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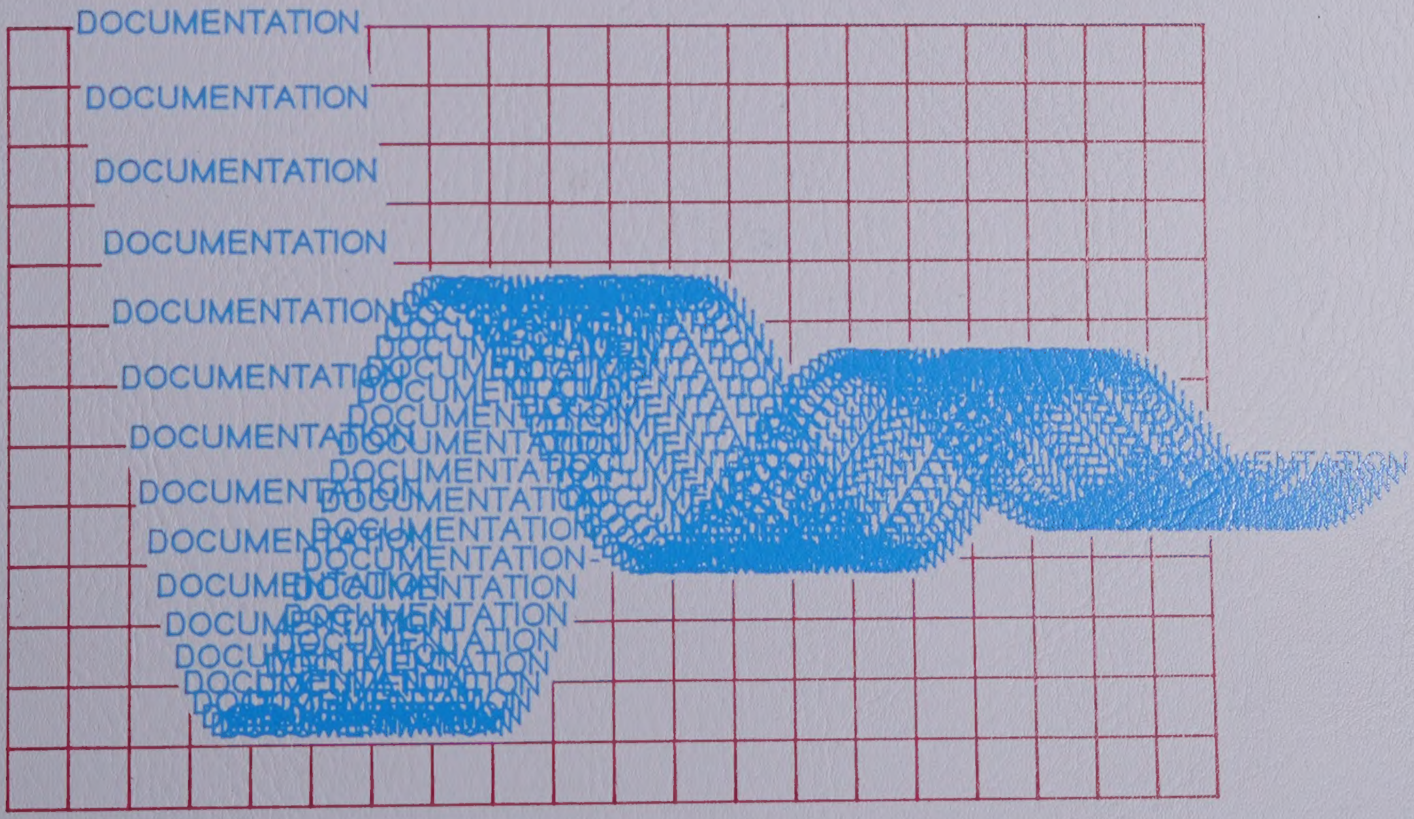
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ROHDE&SCHWARZ
Test and Measurement
Division

Operating Manual

Universal Radio Communication Tester

R&S CMU 200 / CMU 300

1100.0008.02/1100.0008.53/1100.0008.03

Printed in the Federal
Republic of Germany

Dear Customer,

throughout this manual, CMU200 and CMU300 is generally used as an abbreviation for the Universal Radio Communication Testers R&S CMU 200 and R&S CMU 300.

R&S CMU200/CMU300 – Equipment Supplied

The CMU is delivered with the following items:

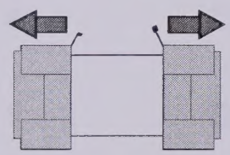
- Universal Radio Communication Tester R&S CMU 200 / R&S CMU 300.
- An AC power cable.
- The following documentation:
  - The present operating manual for R&S CMU 200 / R&S CMU 300.
  - Service manual instrument.
  - Operating manuals for software options and additional equipment purchased with the CMU. All available software manuals are listed before tabbed divider no. 1 of this manual. For a list of options available refer to the data sheet.

R&S CMU Models

The following models of the Universal Radio Communication Tester R&S CMU are deliverable:

- Universal Radio Communication Tester R&S CMU 200, stock no. 1100.0008.02, for all mobile station and user equipment tests including Bluetooth™ device tests.
- Universal Radio Communication Tester R&S CMU 200, stock no. 1100.0008.53, only for Bluetooth™ device tests.
- Universal Radio Communication Tester R&S CMU 300, stock no. 1100.0008.03, for base station tests.

Instructions for Unpacking the Instrument



remove protective cabs

➢ Take the instrument out of the shipping box and check whether the items listed in the packing list above are all included.

➢ Remove the two protective caps from the front and rear of the CMU and carefully check the instrument for damage.

Should the instrument be damaged, immediately notify the forwarder who shipped the instrument to you and keep the box and packing material.

Please observe all safety instructions given in this manual and follow the directions in chapter 1 to put the instrument into operation.

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List of Figures and Tables

Data Sheet

Safety Instructions
Certificate of Quality
EU Certificate of Conformity
List of R&S Representatives

Manuals for Universal Radio Communication Tester CMU

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2 **Chapter 2:** **Getting Started**

3 **Chapter 3:** **Operation**

4 **Chapter 4:** **Functional Description**

5 **Chapter 5:** **Remote Control – Basics**

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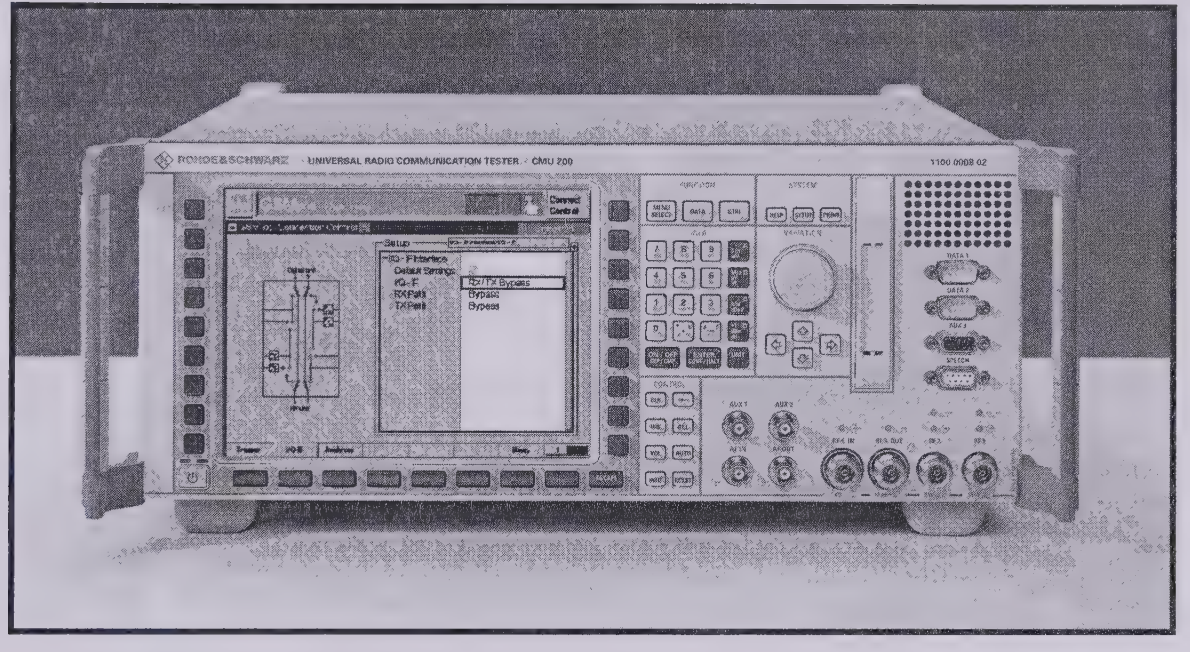
ROHDE&SCHWARZ
UNIVERSAL RADIO COMMUNICATION TESTER · CMU 200
Setup
IQ-IF Interface
Default Settings
IQ-IF
RX Path
TX Path
RX/TX Bypass
Bypass
Bypass

Universal Radio Communication Tester
R&S CMU200

Option R&S CMU-B17
IQ AND IF INTERFACE

Technical Information

The R&S CMU200 in combination with the option R&S CMU-B17 represents an unique solution to get access to different IF- and IQ – signals on up- / down-link signal paths of mobile communication systems. The paper gives an overview about functionality, related applications and technical specifications.

ROHDE&SCHWARZ

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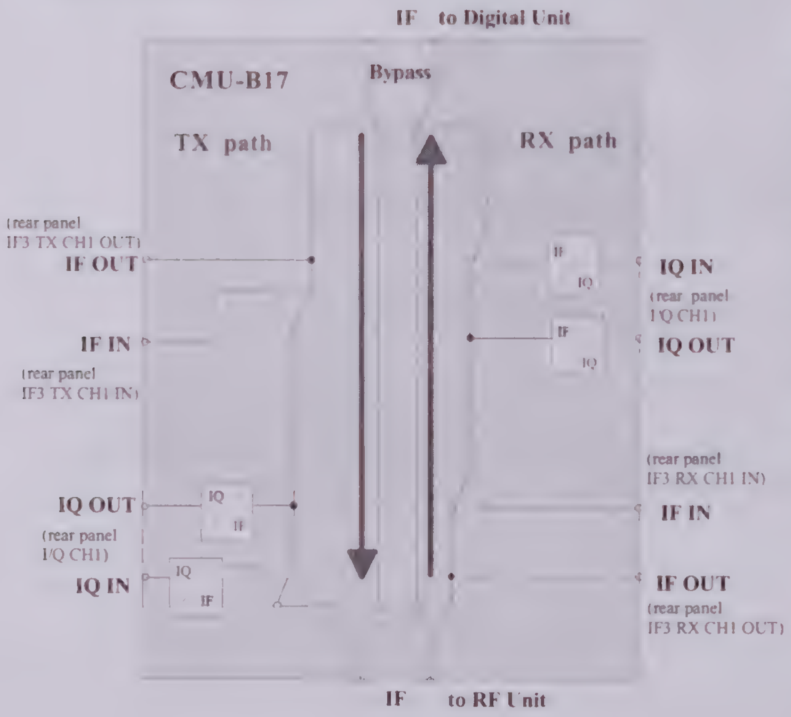
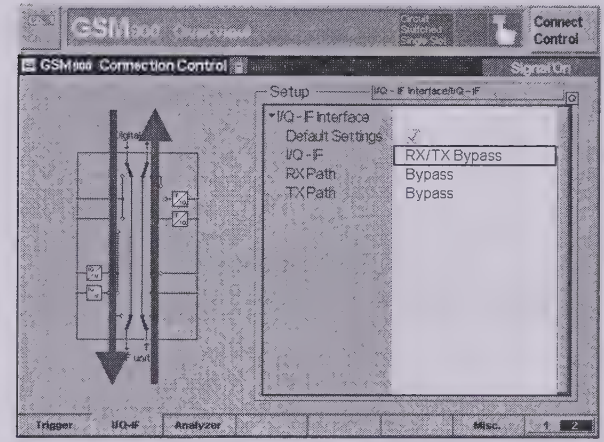
Block diagram


IF to Digital Unit
CMU-B17
Bypass
TX path
RX path
(rear panel IF3 TX CH1 OUT)
IF OUT
IF IN
(rear panel IF3 TX CH1 IN)
IQ OUT
(rear panel I/Q CH1)
IQ IN
IQ
IF
IQ IN
(rear panel I/Q CH1)
IQ OUT
(rear panel IF3 RX CH1 IN)
IF IN
IF OUT
(rear panel IF3 RX CH1 OUT)
IF to RF Unit

Option R&S CMU-B17 provides separate access to IF / IQ signals on R&S CMU200 receiver (RX) and transmitter (TX) paths (pls. see also annex 1). The functionality is applicable for Signalling and Non Signalling measurement modes. The insertion of option R&S CMU-B17 in bypass mode does not cause any influence to signals; i.e. the additional insertion loss of R&S CMU-B17 will be considered during mandatory calibration procedure after installation.

Functionality

Default: Bypass mode for highest measurement accuracy / RF tests


GSM900 Overview
Connect Control
GSM900 Connection Control
Signal On
I/Q - IF Interface/I/Q - IF
Trigger
I/Q-IF
Analyzer
Misc.
1
2

Setup
- I/Q - IF Interface
  - Default Settings ✓
  - I/Q - IF: RX/TX Bypass
  - RX Path: Bypass
  - TX Path: Bypass

Setting: RX/TX Bypass

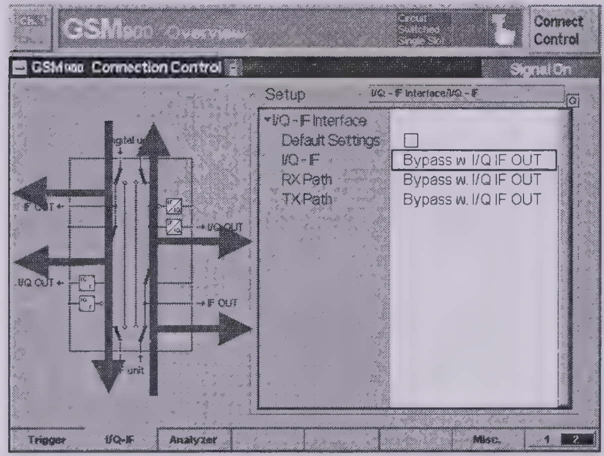
IEEE commands:

```
CONFigure:IQIF:RXTXcombined[?] BYP
CONFigure:IQIF:RXPath[?] BYP
CONFigure:IQIF:TXPath[?] BYP
```

Functionality:

- No influence to transmitted and received signals.
- The path loss due to the inserted R&S CMU-B17 board will be considered automatically during mandatory calibration procedure on R&S ACS calibration system after installation of the option.

IQ / IF signal monitoring


GSM900 Overview
Connect Control
GSM900 Connection Control
Signal On
I/Q - IF Interface/I/Q - IF
IF OUT
I/Q OUT
I/Q OUT
IF OUT
Trigger
I/Q-IF
Analyzer
Misc.
1
2

Setup
- I/Q - IF Interface
  - Default Settings ☐
  - I/Q - IF: Bypass w. I/Q IF OUT
  - RX Path: Bypass w. I/Q IF OUT
  - TX Path: Bypass w. I/Q IF OUT

Setting: Bypass w. I/Q IF OUT

IEEE commands:

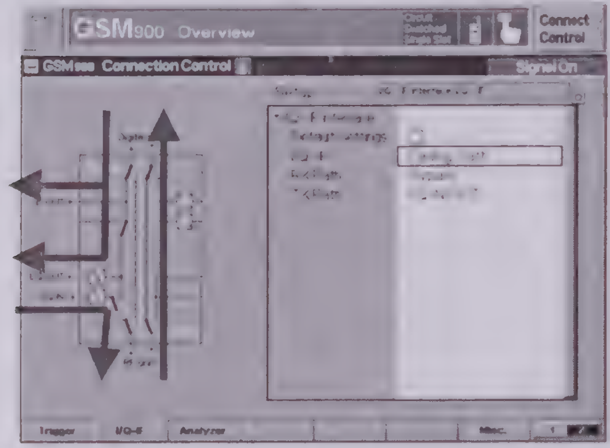
```
CONFigure:IQIF:RXTXcombined[?]
BYIQ
CONFigure:IQIF:RXPath[?] BYIQ
CONFigure:IQIF:TXPath[?] BYIQ
```

Functionality:

- Monitoring of up-link and downlink signals via IF or IQ outputs possible.
- The insertion loss of option R&S CMU-B17 will be considered during calibration procedure (pls. see Annex 4, Specification, Influence on RF interface).
- This mode can also be used for fading applications (pls. refer to chapter Applications, R&S CMU in combination with R&S SMIQ, SMIQ provides the faded RF signal).

Interruption of IQ / IF signal paths for external signal processing

Predefined paths


GSM900 Overview
Connect Control
GSM900 Connection Control
Signal On
Trigger
I/Q-IF
Analyzer
Misc.

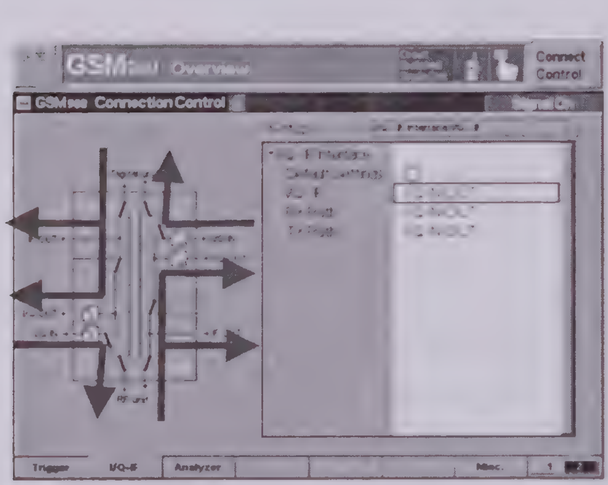
Setting: Fading Path

IEEE commands:

```
CONFigure:IQIF:RXTXcombined[?]
 FPAT
CONFigure:IQIF:RXPath[?] BYP
CONFigure:IQIF:TXPath[?] XOIO
```

Functionality:

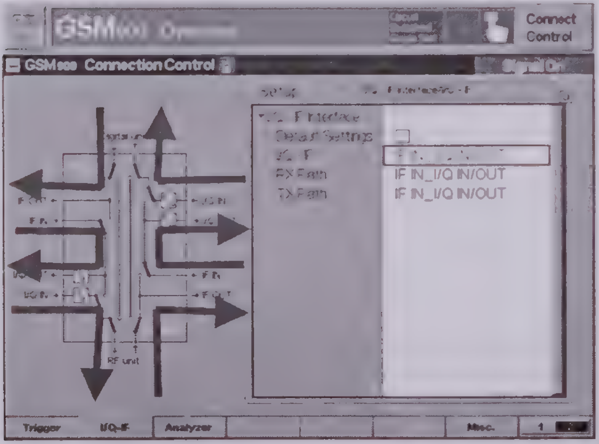
- The setting "Fading Path" can be used for connecting an external baseband fading simulator (pls. refer to chapter Applications, R&S CMU in combination with fading simulator R&S ABFS or R&S SMIQ/SMIQB14, CMU provides the faded RF signal).
- The transmitted signal can be routed to the fading simulator via IF or IQ outputs.
- Additionally it is possible to return the faded signal via IQ input.


GSM900 Overview
Connect Control
GSM900 Connection Control
RF unit
Trigger
I/Q-IF
Analyzer
Misc.

Setting: I/Q IN/OUT

IEEE commands:

```
CONFigure:IQIF:RXTXcombined[?]
 XOIO
CONFigure:IQIF:RXPath[?] XOIO
CONFigure:IQIF:TXPath[?] XOIO
```

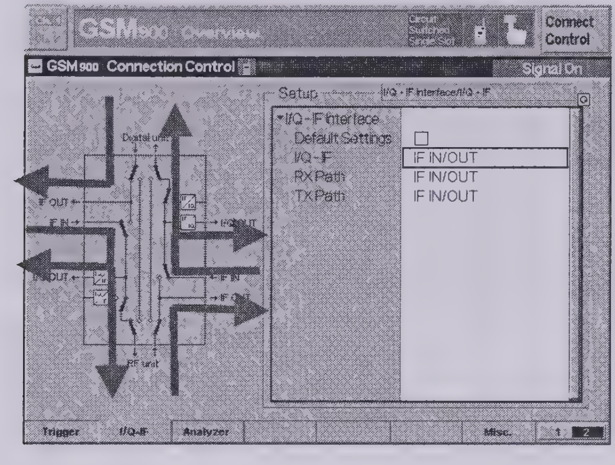

GSM900 Overview
Connect Control
GSM900 Connection Control
RF unit
Trigger
I/Q-IF
Analyzer
Misc.

RX Path IF IN_I/Q IN/OUT
TX Path IF IN_I/Q IN/OUT

Setting: IF IN_I/Q IN/OUT

IEEE commands:

```
CONFigure:IQIF:RXTXcombined[?]
 IOIO
CONFigure:IQIF:RXPath[?] IOIO
CONFigure:IQIF:TXPath[?] IOIO
```


GSM900 Overview
Connect Control
GSM900 Connection Control
Signal On
Digital unit
IF OUT
IF IN
I/Q OUT
I/Q OUT
IF IN
IF OUT
RF unit
Trigger
I/Q-IF
Analyzer
Misc.
1
2

Setup — I/Q - IF Interface/I/Q - IF

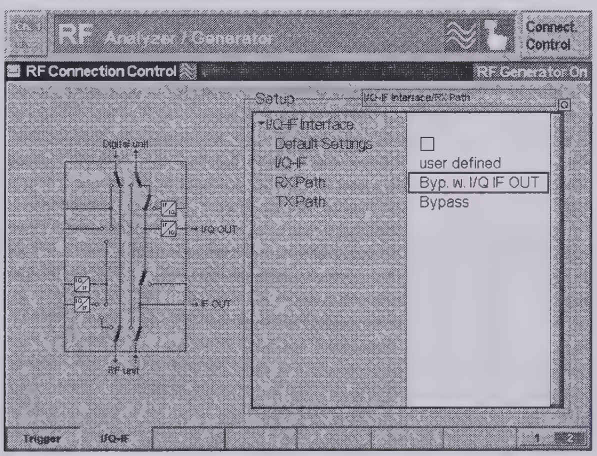
- I/Q - IF Interface
  - Default Settings ☐
  - I/Q - IF: IF IN/OUT
  - RX Path: IF IN/OUT
  - TX Path: IF IN/OUT

Setting: IF IN/OUT

IEEE commands:

```
CONFigure:IQIF:RXTXcombined[?]
 IOXO
CONFigure:IQIF:RXPath[?] IOXO
CONFigure:IQIF:TXPath[?] IOXO
```

User definable signal paths


RF Analyzer / Generator
Connect. Control
RF Connection Control
RF Generator On
Digital unit
I/Q OUT
IF OUT
RF unit
Trigger
I/Q-IF
1
2

Setup — I/Q-IF Interface/RX Path

- I/Q-IF Interface
  - Default Settings ☐
  - I/Q-IF: user defined
  - RX Path: Byp. w. I/Q IF OUT
  - TX Path: Bypass

Setting: user defined

IEEE commands:

```
CONFigure:IQIF:RXPath[?] BYIQ
CONFigure:IQIF:TXPath[?] BYP
```

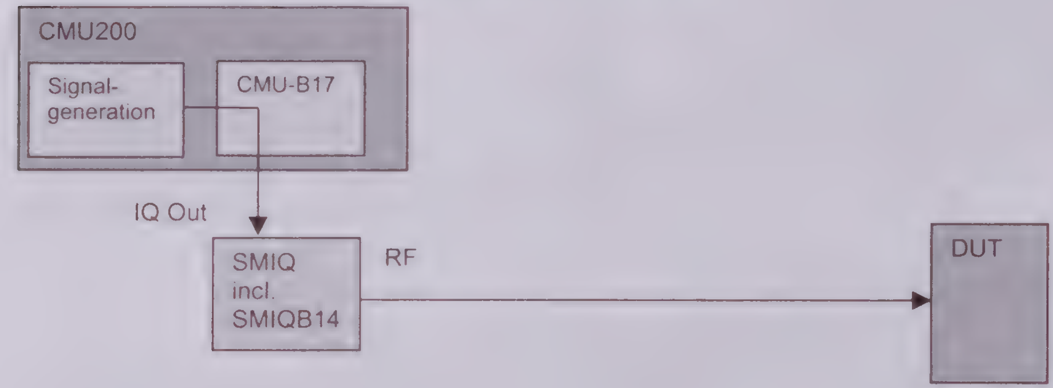
Functionality:
It is possible to select different user specific IQ / IF paths depending on application.

Applications

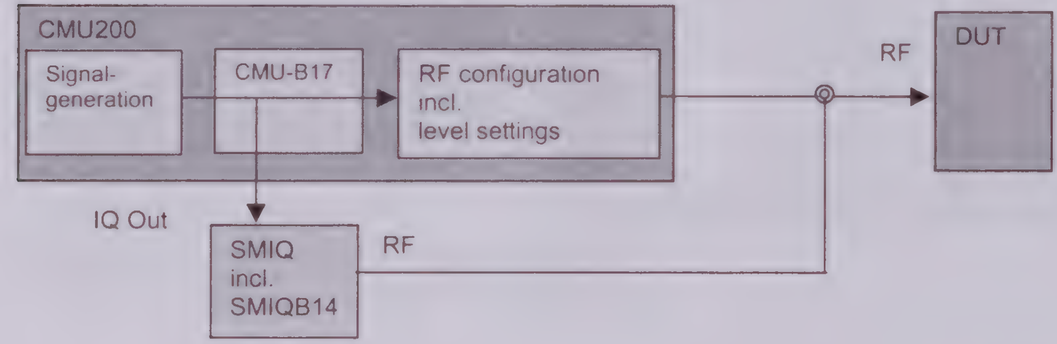
Bit Error Rate measurements on digital receivers under fading conditions

R&S CMU in combination with R&S SMIQ (R&S SMIQ provides the faded RF signal)

R&S CMU200 setting: **Fading Path** or **Bypass w. I/Q IF OUT^**


CMU200
Signal-generation
CMU-B17
IQ Out
SMIQ incl. SMIQB14
RF
DUT

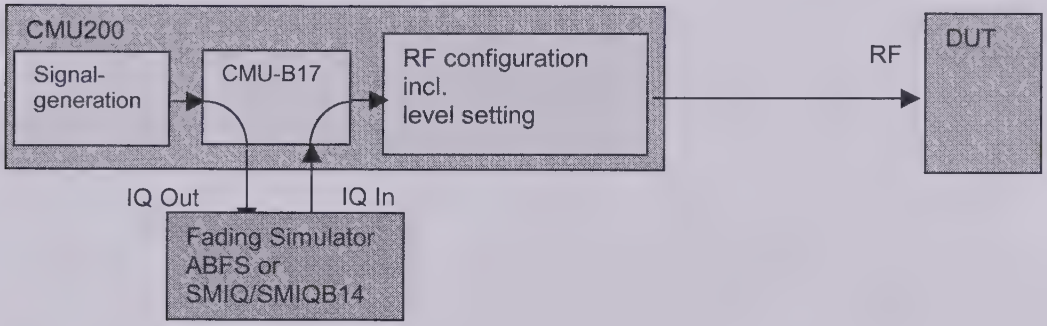
R&S CMU200 setting: **Bypass w. I/Q IF OUT**


CMU200
Signal-generation
CMU-B17
RF configuration incl. level settings
RF
DUT
IQ Out
SMIQ incl. SMIQB14
RF

The R&S CMU incl. option R&S CMU-B17 in combination with signal generator R&S SMIQ incl. IQ fading simulator option R&S SMIQB14 can be used for receiver (RX) Bit Error Rate (BER) tests under fading conditions. The IQ output of R&S CMU-B17 transmitter (TX) path feeds the signal into R&S SMIQ's IQ input. The R&S SMIQ forwards the faded RF signal directly to the receiver (RX) of the Device Under Test (DUT). The illustrated test set-ups are depending on selected mode of option R&S CMU-B17. In Bypass w. I/Q IF OUT mode it is recommended to reduce to minimum the RF level of non faded traffic channel.
For more information please refer to R&S application note 1MA07_0E „SMIQ as Fading Simulator for External Signals“.

R&S CMU in combination with fading simulator R&S ABFS or R&S SMIQ/SMIQB14 (R&S CMU provides the faded RF signal)

R&S CMU200 setting: **Fading Path**


CMU200
Signal-generation
CMU-B17
RF configuration incl. level setting
RF
DUT
IQ Out
IQ In
Fading Simulator ABFS or SMIQ/SMIQB14

The R&S CMU200 incl. option R&S CMU-B17 in combination with IQ fading simulator R&S ABFS or R&S SMIQ/SMIQB14 can be used for receiver tests under fading conditions. In this case the signal is forwarded to the device under test (DUT) via CMU RF interface.

Additional information for GSM:

To avoid influences on the fading profile it is highly recommended:

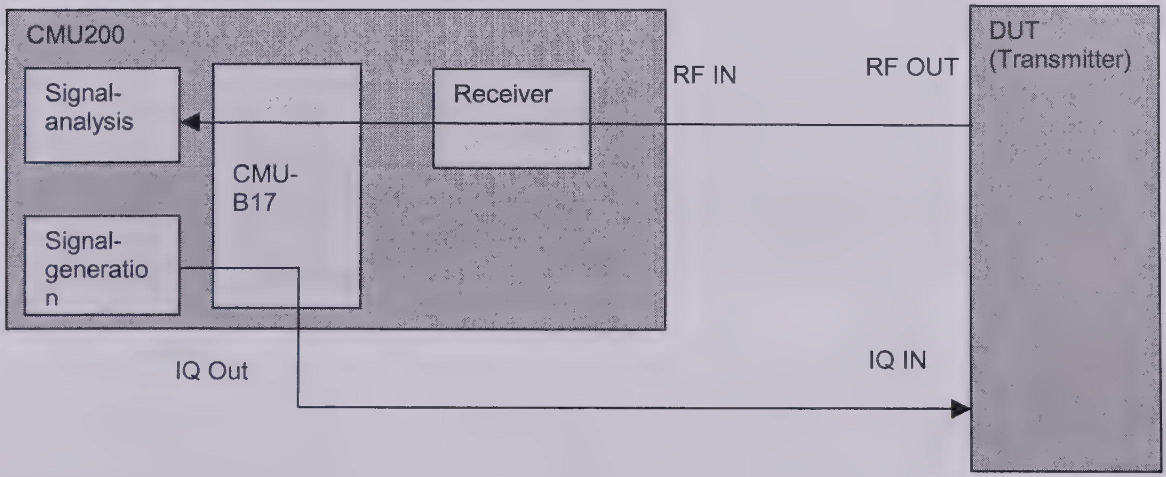
- To set all timeslots to the same level.
- To use for the TX signal of the R&S CMU the same RF frequencies and RF levels for both TCH and BCCH.
- To switch hopping off.

Based on external PC it is possible to perform an automated signal path calibration procedure. Both instruments will be controlled via IEEE interface. An application note incl. software is available on R&S WWW.

R&S CMU200 as IQ generator / RF analyzer

Another important application is the generation of IQ signals meeting the relevant standards. The user can generate complex signals that may even originate from a real signalling sequence. Most mobile radio chipsets comprise a RF chip and a baseband chip that communicate with each other via an analog IQ interface. The R&S CMU-B17 IQ-interface can be used to access the two chips. In mobile radio development, different teams are often required for this purpose. The IQ interface allows development work to be divided in space and time.

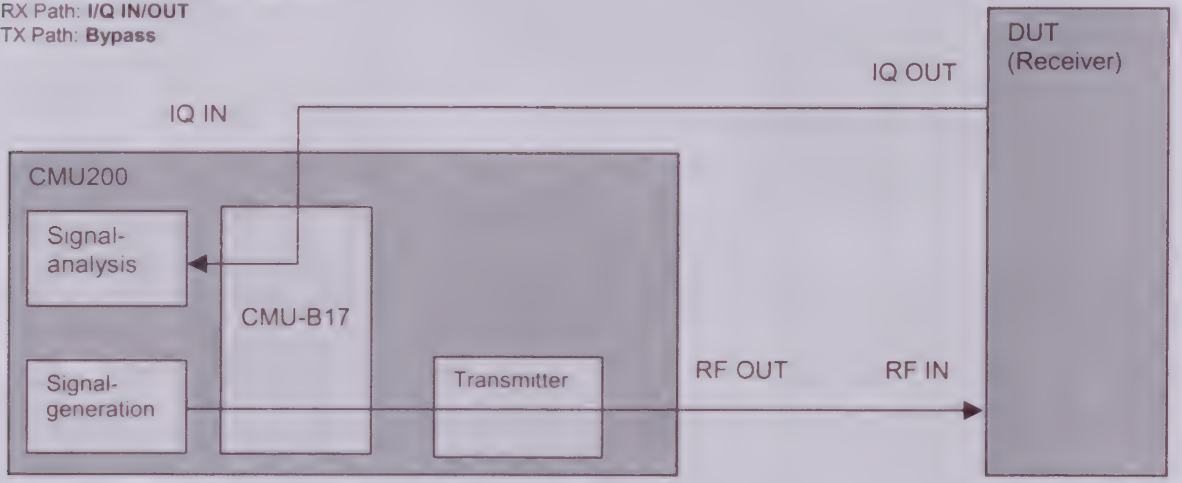
R&S CMU200 setting: **Bypass w. I/Q IF OUT**


CMU200
Signal-analysis
CMU-B17
Receiver
RF IN
RF OUT
DUT (Transmitter)
Signal-generation
IQ Out
IQ IN

R&S CMU200 as RF generator / IQ analyzer

If IQ signals are applied to the receive section of the tester, signal analysis can be performed in the same manner as when feeding a RF signal. In this connection, modulation analysis, for example, is useful since it evaluates the quality of an IQ signal. Modulation analysis yields analysis results such as IQ offset and IQ imbalance, which directly affect IQ signals, or even more complex evaluations such as error vector magnitude (EVM).

R&S CMU200 setting: **user defined**
RX Path: **I/Q IN/OUT**
TX Path: **Bypass**



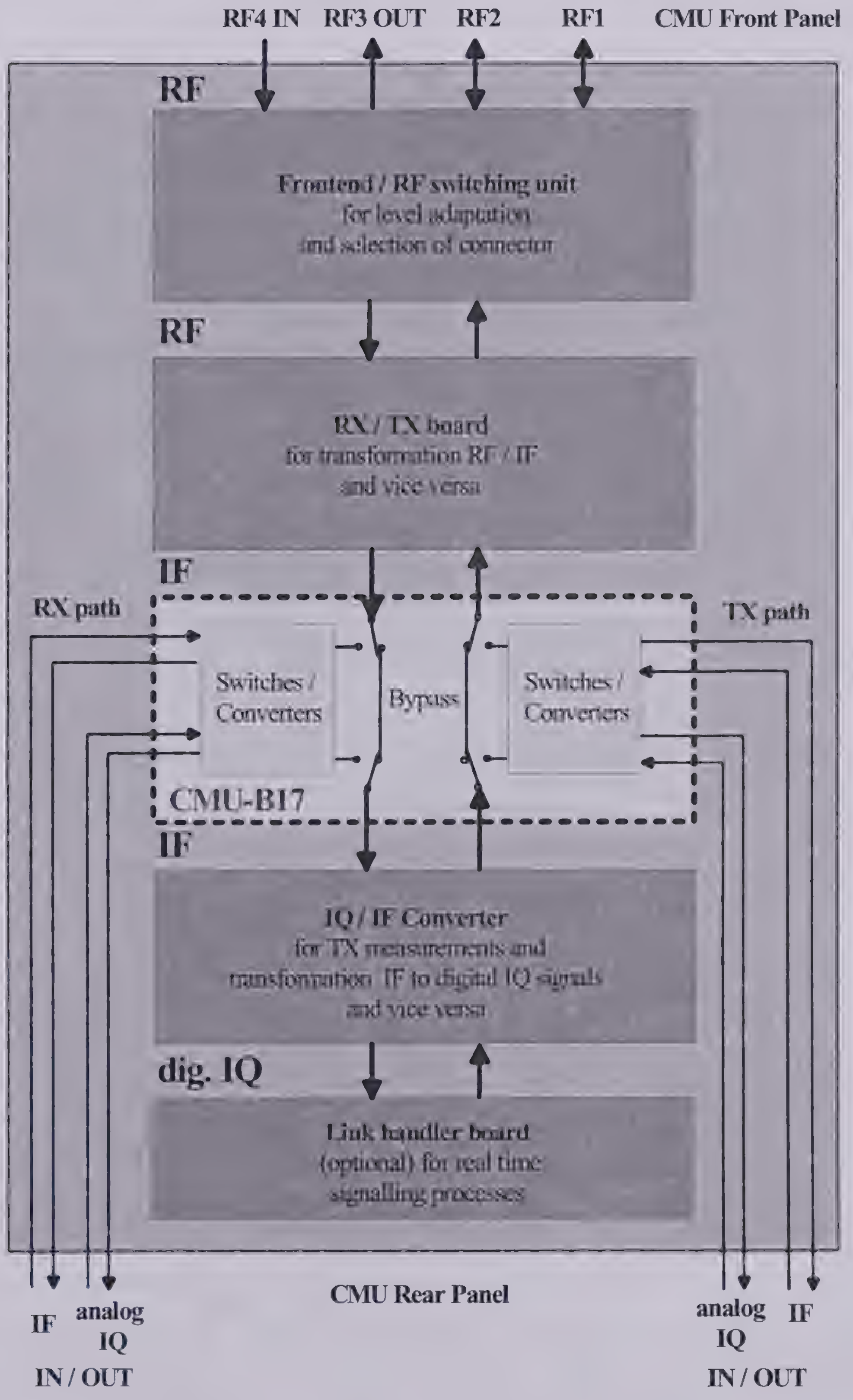
Ordering information

Type Stock.-No	Designation
CMU-B17 1100.6906.02	IQ AND IF INTERFACES FOR CMU200/300, ANALOG, SINGLE CHAN

Remarks:

- The listed R&S CMU200 function groups support the option R&S CMU-B17 from SW version V3.10 on:
  RF
  GSM (GPRS, EGPRS)
  IS136
  CDMA2000 (IS95)
  WCDMA (3GPP FDD)
- Due to used modulation schemes Bluetooth and AMPS standards will not be supported.
- The upgrade of existing units can be performed at R&S Service Center Munich. Installation and calibration costs must be considered in addition to the price of option R&S CMU-B17. Later on it will be possible to perform R&S CMU-B17 upgrades at local R&S Service Centers.
- The options R&S CMU-B17 and R&S CMU-B73 use the same mainboard connector of R&S CMU. Therefore either the R&S CMU-B17 or the R&S CMU-B73 can be ordered for a single instrument.

Annex 1: Signal paths R&S CMU200 incl. R&S CMU-B17


RF4 IN
RF3 OUT
RF2
RF1
CMU Front Panel
RF
Frontend / RF switching unit
for level adaptation
and selection of connector
RF
RX / TX board
for transformation RF / IF
and vice versa
IF
RX path
TX path
Switches / Converters
Bypass
Switches / Converters
CMU-B17
IF
IQ / IF Converter
for TX measurements and
transformation IF to digital IQ signals
and vice versa
dig. IQ
Link handler board
(optional) for real time
signalling processes
CMU Rear Panel
IF
analog IQ
IN / OUT
analog IQ
IF
IN / OUT

Annex 2: Assignment of IQ / IF connectors on R&S CMU rear panel

Sub-D connector I/Q CH1:

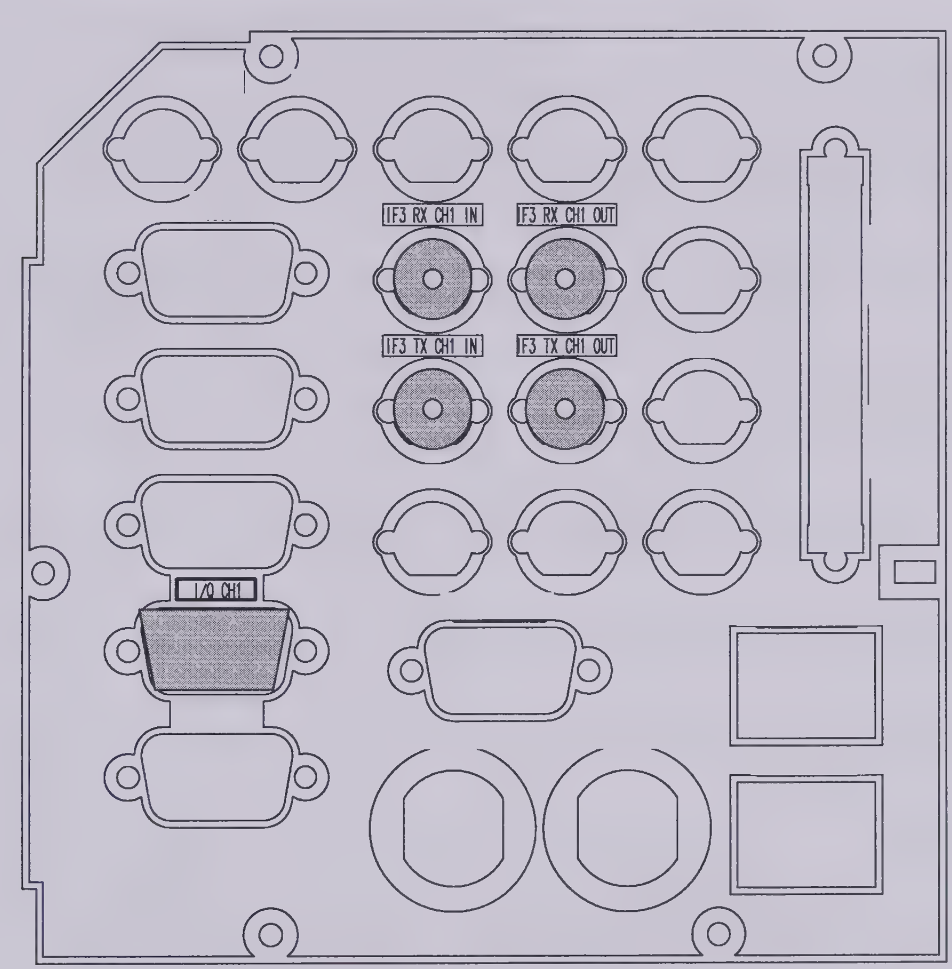
Pin	Signal designation	Function
1	GND	
2	MOD_ I_ IN	I input, TX path, max ±0.5 V, impedance 50 Ohm
3	MOD_Q_IN	Q input, TX path, max ±0.5 V, impedance 50 Ohm
4	GND	
5	MOD_I_OUT	I output, TX path, max ±0.5 V, impedance 50 Ohm
6	MOD_Q_OUT	Q output, TX path, max ±0.5 V, impedance 50 Ohm
7	GND	
8	DEMOD_I_IN	I input, RX path, max ±0.5 V, impedance 50 Ohm
9	DEMOD_Q_IN	Q input, RX path, max ±0.5 V, impedance 50 Ohm
10	GND	
11	DEMOD_I_OUT	I output, RX path, max ±0.5 V, impedance 50 Ohm
12	DEMOD_Q_OUT	Q output, RX path, max ±0.5 V, impedance 50 Ohm
13	GND	
14		
15		

BNC sockets:

Socket designation	PIN*	Function
IF3 RX CH1 IN	BNC	IF input, RX path, f= 7,68 MHZ or 10,7 MHz; max level +2 dBm PEP; impedance 50 Ohm
IF3 RX CH1 OUT	BNC	IF output, RX path, f= 7,68 MHZ or 10,7 MHz; max level +4 dBm PEP; impedance 50 Ohm
IF3 TX CH1 IN	BNC	IF input, TX path, f= 15,36 MHz or 13,85 MHz; max level +3 dBm PEP for WCDMA, max level –5 dBm for GSM; impedance 50 Ohm
IF3 TX CH1 OUT	BNC	IF output, TX path, f= 15,36 MHz or 13,85 MHz; max level +3 dBm PEP for WCDMA, max level –5 dBm for GSM; impedance 50 Ohm

*) The BNC shield is GND.

Annex 3: Location of R&S CMU-B17 connectors on rear panel


IF3 RX CH1 IN
IF3 RX CH1 OUT
IF3 TX CH1 IN
IF3 TX CH1 OUT
I/Q CH1

Annex 4: Specification

IQ Interface

Analogue IQ Outputs (IF->IQ; TX- and RX-Paths, analogue I/Q Output)

(Connector I/Q CH1)

IQ Bandwidth		0 to 2.5 MHz
Max output voltage range	EMF	-1 V to +1 V, peak $\sqrt{I^2+Q^2}$ =1V, peak
Output impedance		50 Ω
I- and Q-Amplitude Imbalance	 For WCDMA function group	< +/- 2 % < +/- 2,5 %
Offset voltage	+20 °C to +35 °C +20 °C to +35 °C for WCDMA function group +5 °C to +45 °C	<4 mV <5 mV <8 mV

Analogue IQ Inputs (IQ->IF; TX-path, analogue I/Q Input)

(Connector I/Q CH1)

IQ Bandwidth		0 to 2.5 MHz
Max input voltage range		-0.5 V to +0.5 V, peak $\sqrt{I^2+Q^2}$ = 0,5V, peak
Input impedance		50 Ω
Carrier suppression	+20 °C to +35 °C +5 °C to +45 °C	>40 dB >35 dB
Side band suppression	f_{iq} < 1 MHz 1 MHz < f_{iq} < 2.5 MHz	>45 dB >40 dB

Analogue IQ Inputs (IQ->IF; RX-path, analogue I/Q Input)

(Connector I/Q CH1)

IQ Bandwidth		0 to 2.5 MHz
Max input voltage range		-0.5 V to +0.5 V, peak $\sqrt{I^2+Q^2}$ = 0,5V, peak
Input impedance		50 Ω
Carrier suppression	+20 °C to +35 °C +5 °C to +45 °C	>35 dB[1] >35 dB[1]
Side band suppression	f_{iq} < 1 MHz 1 MHz < f_{iq} < 2.5 MHz	>45 dB >40 dB

---

[1] For GSMK modulation and max input voltage at IQ inputs

Influence on RF interface

WCDMA Measurements (3GPP FDD, UE test)

Additional influence on signal quality	analogue I/Q Input and Output considered; for TX- and RX-Paths	
EVM		<5 %, rms

GSM / EDGE Measurements

Additional influence on signal quality, EVM	Analogue I/Q Input and Output considered; for TX- and RX-Paths;	
Phase error	GMSK	<3°, peak <1°, rms
EVM	8PSK	<5 %, rms

RF Level uncertainty (Bypass with IQ/IF OUT, IQ IN/OUT, IF IN/OUT)

Additional output level uncertainty, related to CMU data sheet	At RF1, RF2, RF3 OUT	<0.3 dB
Additional input level uncertainty, related to CMU data sheet	At RF1, RF2, RF4 IN (frequency-selective)	<0.3 dB

IF Interface

IF Inputs, TX Path
(Connector IF3 TX CH1 IN)

IF level range		up to -5 dBm, PEP
Standard IF frequencies	RF/GSM/IS136/AMPS/IS95/CDMA2000 WCDMA	13.85 MHz 15.36 MHz

IF Inputs, RX Path
(Connector IF3 RX CH1 IN)

IF level range		up to +2 dBm, PEP
Standard IF frequencies	RF/GSM/IS136/AMPS/IS95/CDMA2000 WCDMA	10.7 MHz 7.68 MHz

IF Outputs, TX Path
(Connector IF3 TX CH1 OUT)

IF level range		up to -5 dBm, PEP
Standard IF frequencies	RF/GSM/IS136/AMPS/IS95/CDMA2000 WCDMA	13.85 MHz 15.36 MHz

IF Outputs, RX Path
(Connector IF3 RX CH1 OUT)

IF level range		up to +4 dBm, PEP
Standard IF frequencies	RF/GSM/IS136/AMPS/IS95/CDMA2000 WCDMA	10.7 MHz 7.68 MHz

Aspects to be considered, if TX or RX signal paths are interrupted *:

The RF frequency of the R&S CMU influences the rotating direction of the IQ vector.
The direction is inverted for RF < 1200.1 MHz, this can be compensated by changing I and Q

	R&S CMU generator or analyzer RF frequency	
	100 kHz.. 1200.0999999 MHz	1200.1.. 2700.0 MHz
R&S CMU IQ output vector	Inverted rotation. Swap I-output with Q-output for proper operation	Normal rotation
R&S CMU IQ input vector	Inverted rotation. Swap I-input with Q-input for proper operation	Normal rotation

*) Please refer to Annex 1. The rotating direction must be considered, if the R&S CMU signal path from Link Handler Board to Frontend and vice versa is interrupted; i.e. if the signal is not returned to the same R&S CMU block after external treatment. Examples:

- The rotating direction must **not** be taken into account, if the transmitted signal is routed from IQ output of R&S CMU-B17 to an external fading simulator and than returned to IQ input of CMU (pls. refer to chapter Applications, R&S CMU in combination with fading simulator R&S ABFS or R&S SMIQ/SMIQB14, R&S CMU provides the faded RF signal).
- The rotating direction must be considered, if the transmitted signal is forwarded to an external fading simulator and is not returned to IQ input of R&S CMU (pls. refer to chapter Applications, R&S CMU in combination with R&S SMIQ, R&S SMIQ provides the faded RF signal).

Notes for measuring IQ / IF signals, applied to inputs of option R&S CMU-B17 on R&S CMU RX path:

- The RF spectrum analyzer function (RF Function Group) is not applicable.
- The displayed RF power levels are not directly related to applied IQ / IF voltages. The analyzer settings of R&S CMU RF interface (RF1, RF2, RF 4 IN) have to be considered additionally (softkeys Analyzer Level / RF Max. Level).
    - IQ inputs have a fixed attenuation of 2 dB; e.g. the RF power meter readout for an applied 500 mV IQ peak voltage will be 2 dB below the set RF Max. Level value.
    - IF inputs do not have a fixed attenuation. The max. IF input level is 2 dBm. The RF power meter readout for the mentioned max. IF signal level (2 dBm) will be 2 dB below the set RF Max. Level value.
- It is recommended to switch off the Autoranging Function.
- RF and IF trigger functions are not possible.
- WCDMA RF Compensation filter is switched off (I/Q IN/OUT, IF IN/OUT, IFIN_I/Q IN/OUT)
- WCDMA UE-Test: ACLR/SEM measurement is not applicable

WCDMA
CDMA2000
Bluetooth
cdmaOn
Analog
TDM

Universal Radio Communication Tester CMU200

THE multiprotocol tester for current and future mobile radio networks

- Extremely high-speed testing
- Highly accurate measurements
- Modular future-proof design
- Comprehensive spectrum analyzer
- Fast switching between networks

ROHDE & SCHWARZ

Testing the 3rd generation

For more than 60 years Rohde&Schwarz has always been at the forefront of mobile radio technology. We continue this tradition of RF test and measurement with the Universal Radio Communication Tester CMU 200. The CMU 200 is a third-generation platform design that offers true scalable multimode functionality.

The CMU 200 reflects the long-standing expertise Rohde&Schwarz has gained in the world of mobile radio. In recent years, the company has helped to launch overwhelmingly successful mobile radio systems.

Rohde&Schwarz is a preferred supplier to many of the leading mobile equipment manufacturers and is the market leader for mobile radio test sets.

The CMU 200 is part of a complete range of mobile radio test equipment, encompassing everything from conformance test systems to system simulators, turnkey functional board test / final test systems and simple sales-counter Go/NoGo testers.

The base unit with its standard-independent module test provides many general-purpose measurement facilities for the development of all kinds of standards within its wide and continuous frequency range. If extended by the relevant options, the CMU 200 offers the hardware and software necessary to handle your 3G, 2.5G and previous-generation testing applications, including analog.

Low cost of ownership

Selecting the CMU 200 is a decision for the future and results in a total cost of ownership which is sure to be among the lowest due to the following factors:

- Completely modular design of hardware and software components avoids unnecessary investments right from the start just because there is a possibility of a feature being needed sometime in the future. You only pay for what you need
- Should an extension become necessary because your needs widen after some time – the modularity of the CMU 200 concept will cater for that. Many extensions to the unit may be installed onsite. You only pay for it when you need it
- The concept allows two complete channels (RF, signalling and evaluation) to be installed in one CMU 200 unit
- Maximum production output in a compact 4-rack-unit-high package with minimum power dissipation allows compact production space layout
- With the CMU 200 user interface even less experienced users will intuitively get it right without the need for extensive training
- A new remote interface syntax reflects the inherent modularity of this real multimode tester

DESIGN AWARD WINNER 1998

Universal Radio Communication Tester CMU

The CMU 200 targets a wide range of applications, but is primarily optimized for the high accuracy and speed demanded in an ever more quality-conscious manufacturing process. The picture shows the front panel for desktop use.

Applications

- RF development
- Module design
- Module test in production
- Adjustment of mobiles
- Final test in production
- Functional test
- Feature test
- High-end service
- Quality inspection
- Basis for test systems
- Base station simulation

Usability

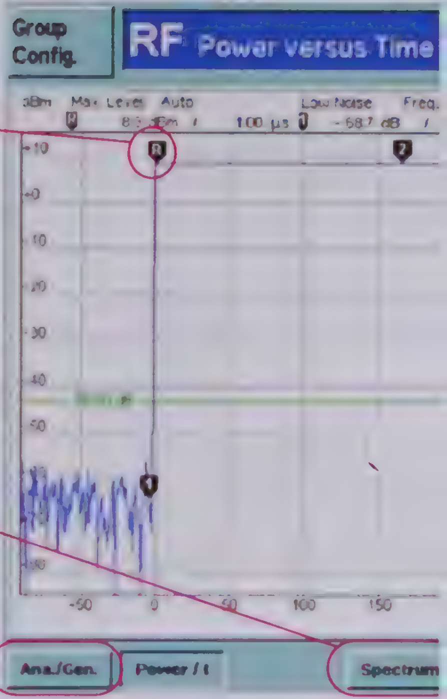
The CMU 200 key strengths

The Radio Communication Tester CMU 200 brings premium cost effectiveness through a variety of features, with extremely fast measurement speed and very high accuracy being the two most important ones. In addition, the secondary remote addressing of the unit's modular architecture makes for intelligent and autonomous processing of complete measurement tasks and fast control program design.

Greatest accuracy

In a production environment the unit's high accuracy allows DUTs (devices under test) to be trimmed for maximum battery lifetime without compromising quality. In the lab, the CMU 200 enables the development engineer to partly replace conventional, dedicated premium-quality instruments and save desktop space at the same time. High-precision measurement correction over the whole frequency and dynamic range as well as compensation for temperature effects in realtime are critical factors for achieving the CMU 200's excellent accuracy.

The globally standardized Rohde & Schwarz calibration system can check the CMU 200's accuracy in a service center close to you or, volume permitting, on your premises. A world-wide network of these standardized automatic calibration systems has been implemented in our service centers. Highly accurate and repeatable calibration can be performed wherever you are. Your local Rohde & Schwarz representative offers customized service contracts for the unit. For large-scale users of the CMU 200, a compact level verification system is available in addition.



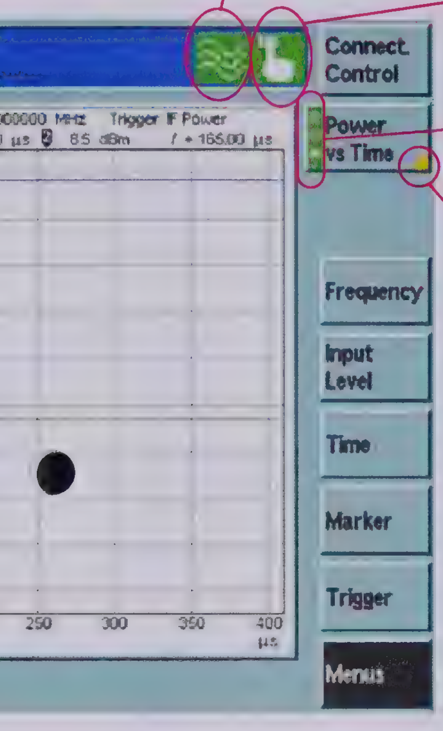
Thanks to the high resolution of the extremely bright high-contrast TFT display even the finest details can be displayed

Direct branching to all associated menus makes for a uniquely flat menu structure

Greatest speed

The high processing speed is due to extensive use of ProbeDSP™ technology, parallel measurements and innovative remote command processing.

- ProbeDSP™ technology
  The modular architecture relies on decentralized ProbeDSP™ processing coordinated by a powerful central processor. Like an oscilloscope probe, DSPs dedicated to a specific local data acquisition and evaluation workload help to keep subsystem performance at an uncompromising maximum even if additional modules are fitted to the CMU 200 mainframe.
- Parallel measurements
  Several RX and TX measurements can be performed in parallel. This is achieved by the fast response of the CMU 200's modular hardware as well as the high overall processing power of the unit and the avoidance of bottlenecks by dedicated operation of the ProbeDSP™ technology employed. Examples of parallel operation are measurements of BER and simultaneous phase/frequency error, EVM, magnitude error and audio, or the various spectrum measurements.
- Innovative remote processing
  The novel secondary addressing mode can address similar functions of each of the CMU 200 subsystems (i.e. different mobile radio standards) in an almost identical way. Using this type of addressing, new remote test sequences can be programmed by a simple cut and paste operation followed by editing specific commands to adapt the control program to the new application. Secondary addressing is fully SCPI-compliant, which means that a subsystem address, for example WCDMA-FDD, can be replaced by a string denoting a different subsystem, i.e. another mobile radio standard.



As the CMU 200 offers many of its measurements in signalling and non-signalling mode, this easy visual indication of the signalling state is provided as part of the status line

This symbol shows the instrument status, i.e. remote or manual operation

For increased speed, measurements not required can be switched off to free resources for the measurements you want to focus on

Measurements are configured by pressing the softkey marked with the yellow triangle two times

Greatest reliability

The CMU 200 employs an ultra-effective heat management between housings and individual components as well as between heat sinks and air flow. Together with the independent cooling cycles for different modules, this adds up to an optimized cooling system.

The base unit

The base unit without any options installed can be used for testing general parameters of 1st, 2nd or 3rd generation mobile phones. The CMU 200 base unit is the ideal solution for tasks at module level, i.e. at the early production stages of all cellular standards.

Constituent parts of the CMU 200 base unit are the RF generator and RF analyzer which are complemented by a versatile, network-independent time domain menu and a comprehensive spectrum analyzer. The illustration above shows a power versus time measurement as an example.

By combining graphical and numerical overview menus the user can select the optimal view when the CMU 200 is in manual mode.

The menu structure of the CMU 200 is very flat and uses context-sensitive selection, entry and configuration pop-up menus.

Advanced operational ergonomics have been incorporated into a most compact and lightweight, 4-rack-units-high package.

Key advantages of the CMU 200

Speed

- ◆ Unrivalled speed of single measurements

Accuracy

- ◆ Incomparable accuracy
- ◆ Excellent result repeatability

Modularity

- ◆ Modular hardware and software concept provides easy extension to further functionality

Reliability

- ◆ Extremely low power consumption and effective heat conduction result in unparalleled reliability

Future-proof

- ◆ Easy migration to emerging standards

Optimized solutions for your production test requirements

Rohde&Schwarz supports CMU 200-based production test solutions through a comprehensive network of application engineering sites. The backbone of this network consists of the four system integration centers located in Asia, North America and Europe.

[illegible]

Regional center project teams offer local system integration, service and support. A team of experts is ready to provide turnkey solutions, including test case programming. Custom-tailored project solutions and site process optimization are major aspects of our services. For fully automated production environments, we offer inline solutions together with our partners in the field of automation. As an example, a fully automated final test fixture including RF test, audio test, keypad test and optical inspection is shown in the picture.

Time to market

The key to commercial success is the time required to get a new product to market in large numbers. The crucial point is the fast transition from product development to mass production. The Cellular Phone Production Test Platform TS7100 featuring the CMU 200 meets this challenge.

TS7100 description in brief

The stringent requirements to be met in the production of mobile phones make it necessary to implement new strategies for the specification of test systems. The test system architecture is based on two CMU 200s to provide optimum throughput.

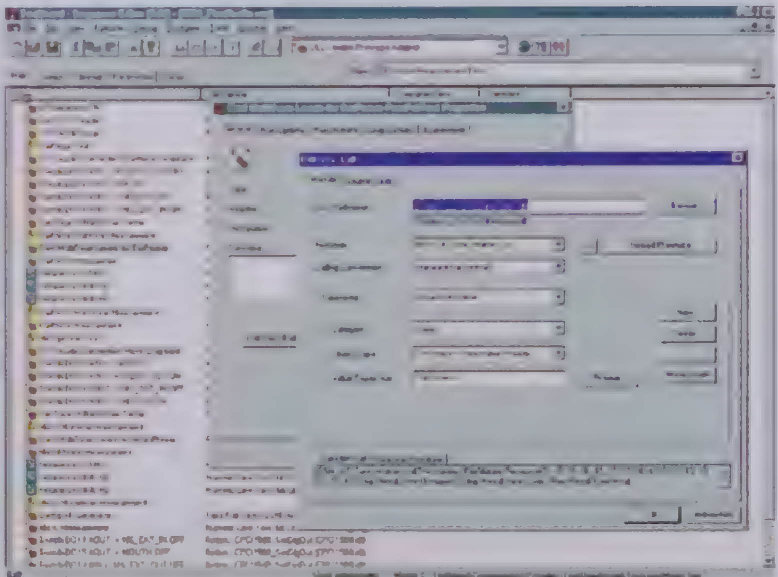
The TSVP (Test System Versatile Platform) test platform is based on the industry standard Compact PCI/PXI. This new type of bus is up to 6 times faster than previous industry bus standards. The TSVP's CompactPCI frame is 100% compatible to the industry standard but features 14 up to 31 slots. It comprises a state-of-the-art controller PC, a digital multimeter and selectable switching and test modules. For each DUT the test hardware for switching and stimulus functions is implemented as a dedicated set of modules.

The TSVP takes up all modules used for control and additional measurements.

Off-the-shelf CompactPCI/PXI modules can be added. Up to 4 sets of modules for testing DUTs can be inserted. The software can thus simultaneously use the resources of the parallel equipment to maximize speed in highly automated production. We can offer optimally configured test systems customized to your production environment.

Test executive & generic test software library features

The parallel hardware is fully supported by TestStand, the industry-wide test executive from National Instruments. A user-friendly connection to the available device drivers has been created to provide faster use of the test executive. This connection is established by the Generic Test Software Library (GTSL). At the same time the toolkit concept provides ready-to-run test cases, which can be customized by the user as required.

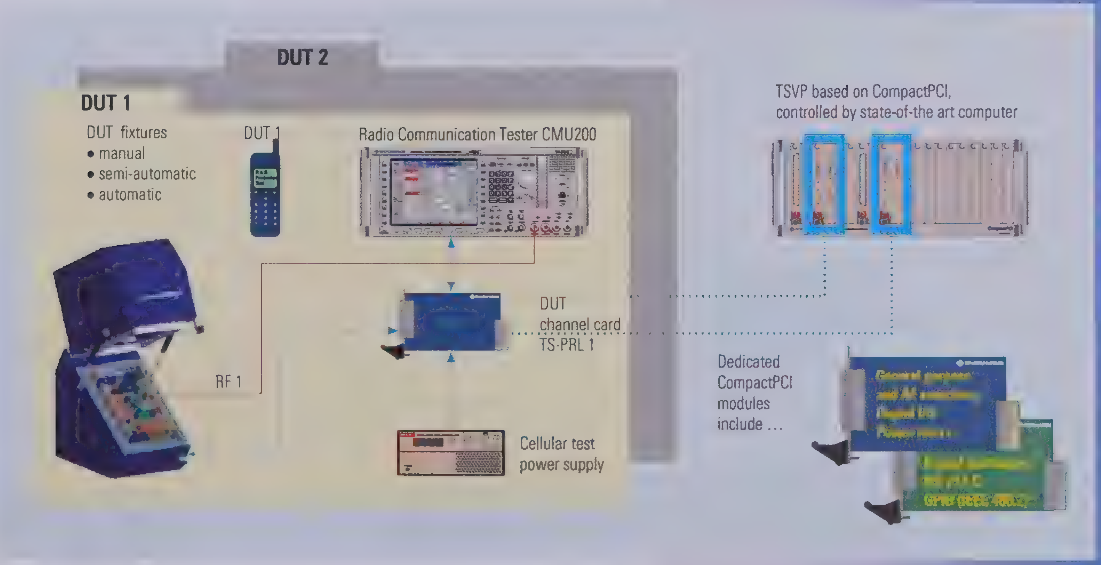


GTSL in action

TS7100: example of a 2-channel ultra-low-profile configuration with PSU and switch matrix fitted to rear of rack

Software concept in brief

- Software platform based on LabWindows/CVI and TestStand from National Instruments
- GTSL includes ready-to-run test cases for the standards supported by the CMU200
- Functional test sequences for RF test, calibration, signalling test, audio and acoustic test of mobile phones are supported
- Transparent and open library can be extended by the user
- Operator interface and test cases can be easily customized
- Parallel test of multiple cellular phones is fully supported
- GTSL supports multithreading and instrument sharing if needed
- Test development time is reduced by as much as 80 %


DUT 2
DUT 1
DUT fixtures
• manual
• semi-automatic
• automatic
DUT 1
Radio Communication Tester CMU200
RF 1
DUT channel card TS-PRL 1
Cellular test power supply
TSVP based on CompactPCI, controlled by state-of-the art computer
Dedicated CompactPCI modules include ...

Block diagram for a 2-channel configuration of TS7100

TS7100 features in brief

- High throughput by parallel testing of cellular phones
- All hardware and software components based on industry standards
- System controller based on CompactPCI/PXI bus arcitecture
- One system for functional board test, phone calibration and final test
- One system for all major cellular phone standards
- Easy expansion to 3rd generation technologies
- Ready-to-run Rohde & Schwarz test library for immediate use or customization
- Modular and versatile hardware/software platform
- Reduced costs due to generic concept

For more detailed information see separate TS7100 data sheet (PD 757.5737).

Ready for today's networks . . .

GSM today

Since its introduction in the early nineties, the GSM system has won acceptance and undergone an evolution that no one could have foreseen

The applications of the GSM system are numerous and are currently

- GSM400
- GSM850
- GSM900 including
  - P-GSM (primary GSM)
  - E-GSM (extended GSM)
  - R-GSM (railway GSM)
- GSM1800 (DCS)
- GSM1900 (PCS)

Whether the application is in production, service or development, the flexible concept of the CMU 200 caters for practically all requirements, from basic RF signal generation, frequency, power and spectrum analyzer measurements for alignment of modules in production or development, to full GSM-specific signalling in any of the above-mentioned bands, as well as module tests on frequencies anywhere in the range from 10 MHz to 2700 MHz.

Signalling tests

The CMU200 simulates a GSM base station RF interface providing the signalling flexibility necessary to test the behaviour of the mobile under the influence of different signalling parameters. These parameters are normally set by the network operator but can be reproduced by the CMU200 for test purposes. The unit supports the latest fast location update and direct paging features.

ETSI MEMBER

...making the right connections.

Reduced signalling synchronized mode

The CMU 200 provides the same functionality as in the signalling mode, but discards any signalling reaction from the mobile connected. This mode of operation enables both testing of modules that only have layer 1 operation and very fast RF testing in production environments. It can also skip the location update procedure in order to save time.

Non signalling mode

This mode serves for generating a signal with GSM-specific midambles and modulation in the entire frequency range from 10 MHz to 2.7 GHz. The analyzer offers the same flexibility for GSM-specific transmitter measurements such as

- modulation analysis
- average and peak burst power
- power versus time, power versus slot, power versus frame
- spectrum due to switching/modulation

GSM development

As an all-round tool for GSM development engineers, the CMU 200 is an unsurpassed solution. The RF interface provides four input and output connectors offering a wide range of signal levels for generation and analysis of RF signals. Input only, as well as combined input/output connectors, can analyze mobiles or modules with a sensitivity down to –80 dBm and up to +47 dBm for the power meter. RF signals can be generated with levels from –130 dBm up to +13 dBm, depending on the selected connector. All measurement tolerances are set by default according to the GSM 11.10 and GSM 05.05 recommendations but may of course be altered to suit individual needs.

Production of mobile phones

Production is a process that calls for cost effectiveness. The CMU 200 concept is optimized for IEC/IEEE-bus speed, measurement accuracy and reproducibility as well as cost of ownership. Thanks to the multitasking feature and parallel measurements, previously unobtainable test times can be achieved.

The ability to process BER data and perform transmitter measurements at the same time, allows phase / frequency error, power versus time and average power (PCL accuracy) to be measured during the time-consuming receiver test.

The accuracy and reproducibility ensure correct and steady measurement results and thus contribute to the quality and reliability of the end product.

GSM evolution – 2.5G

The amount of data traffic in GSM networks is growing rapidly. Multislot applications such as HSCSD or GPRS together with the innovative 8PSK modulation scheme EDGE are needed to cater for the increase in data traffic. The CMU 200 platform is not only able to handle today's standards and systems but is also designed for the needs of tomorrow.

Multislot

In the future, mobile phones will be able to use several timeslots simultaneously for data transmission and reception to further increase the data rate. The simultaneous transmission and reception of several timeslots (multislot) is the technological

GSM

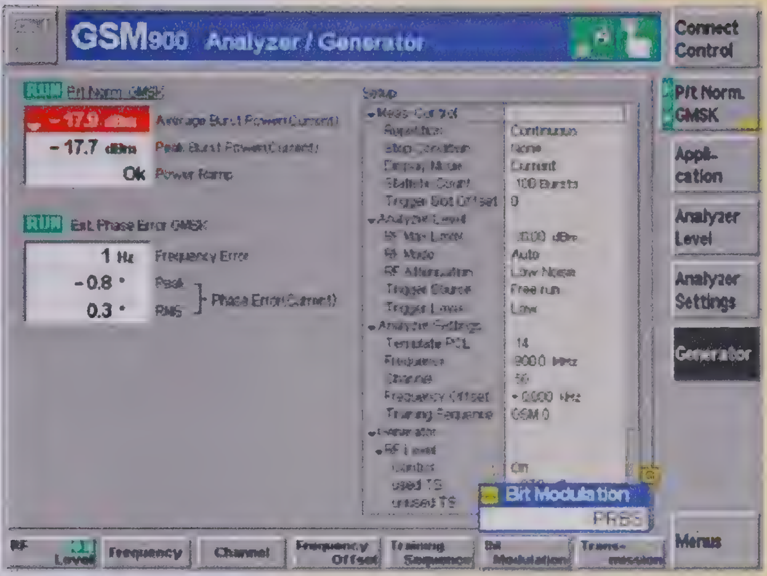
GLOBAL SYSTEM FOR MOBILE COMMUNICATIONS

challenge for circuit-switched and packet-switched applications. The following extensions of the GSM single-slot measurements enable maximum flexibility in development, and, due to minimum measurement times, maximum throughput in production.

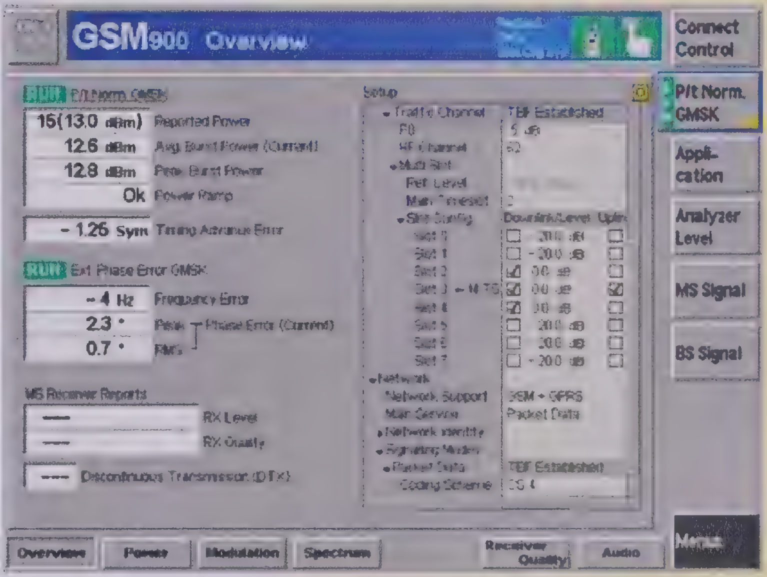
- Individual levels for all timeslots used in the downlink (DL). The CMU generates up to eight timeslots per frame in the downlink; each timeslot can be assigned a separate level. The excellent level stability of the CMU 200 generator is not impaired by multislot transmission using different levels, and allows the most accurate receiver sensitivity measurements (BER/DBLER).
- Transmitter and receiver measurements are possible on every timeslot used. The new multislot concept allows independent measurements on any timeslot (TS 0 to 7) and thus covers the current and future multislot combinations without restrictions.
- Power-versus-time measurement (graphical display) for up to four timeslots in the uplink (UL). The templates of this application are evaluated independently for each timeslot – in line with standards and according to recommendations. Both GMSK- and 8PSK-modulated signals are recognized, and the templates of the relevant timeslot are set in realtime.

Multislot measurements are required for HSCSD and ECSD technologies as well as for GPRS and EGPRS.

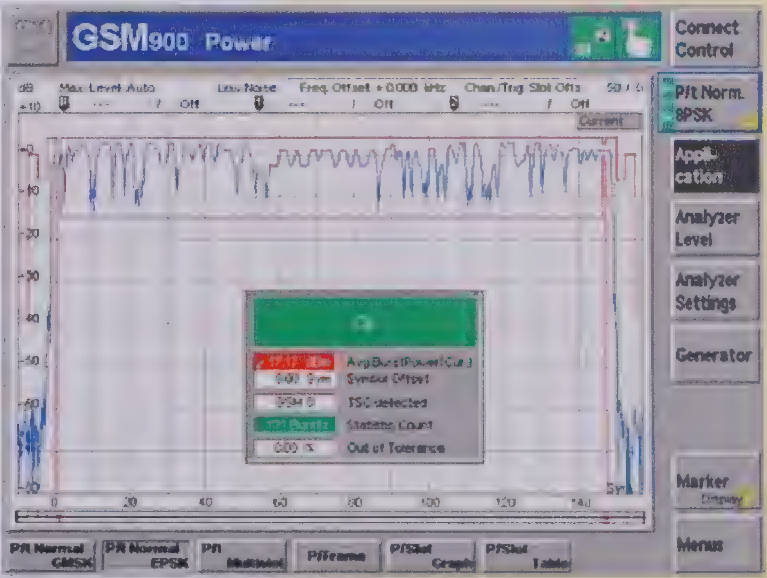
GSM-specific non-signalling test provides generation and analysis of RF signals for testing RX/TX modules or mobiles in service mode


GSM900 Analyzer / Generator
Connect Control
P/t Norm. GMSK
Appli-cation
Analyzer Level
Analyzer Settings
Generator
Menus
RUN
– 17.9 dBm
Average Burst Power(Current)
– 17.7 dBm
Peak Burst Power(Current)
Ok
Power Ramp
RUN
Ext. Phase Error GMSK
1 Hz
Frequency Error
– 0.8 °
Peak
0.3 °
RMS
Phase Error(Current)
Setup
Continuous
None
Current
100 Bursts
0
Auto
Low Noise
Free run
Low
14
900.0 MHz
50
+ 0.000 kHz
GSM 0
On
Bit Modulation
PRBS
RF Level
Frequency
Channel
Frequency Offset
Training Sequence
Bit Modulation
Trans-mission

The overview menu provides fast comprehensive information on the mobile's RF performance; the hotkeys at the bottom of the screen give immediate access to specific and detailed GSM measurements

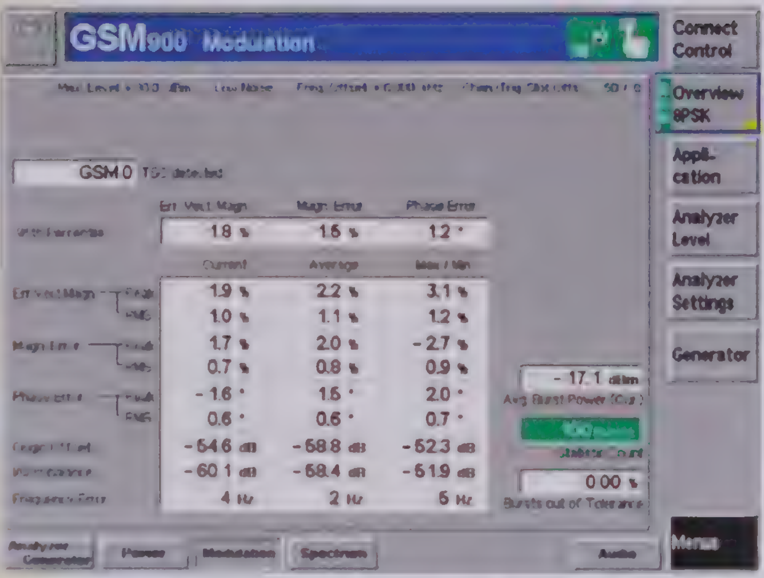

GSM900 Overview
Connect Control
P/t Norm. GMSK
Appli-cation
Analyzer Level
MS Signal
BS Signal
Menus
RUN
15(13.0 dBm)
Reported Power
12.6 dBm
Avg. Burst Power (Current)
12.8 dBm
Peak Burst Power
Ok
Power Ramp
– 1.26 Sym
Timing Advance Error
RUN
Ext. Phase Error GMSK
– 4 Hz
Frequency Error
2.3 °
Peak
0.7 °
RMS
Phase Error (Current)
MS Receiver Reports
RX Level
RX Quality
Discontinuous Transmission (DTX)
Setup
Traffic Channel
TBF Established
GSM + GPRS
Packet Data
TBF Established
Overview
Power
Modulation
Spectrum
Receiver Quality
Audio

In the GSM non-signalling function groups the possibility of switching between GMSK and 8PSK (EDGE) is already implemented so that EDGE bursts as shown here can easily be analyzed


GSM900 Power
Connect Control
P/t Norm. 8PSK
Appli-cation
Analyzer Level
Analyzer Settings
Generator
Marker Display
Menus
Max. Level Auto
Low Noise
Freq. Offset + 0.000 kHz
Off
Current
0
20
40
60
80
100
120
140
Avg.Burst Power(Cur.)
Symbol Offset
TSC detected
Statistic Count
Out of Tolerance
P/t Normal GMSK
P/t Normal EPSK
P/t Multislot
P/Frame
P/Slot Graph
P/Slot Table

8PSK modulation – EDGE

Besides multislot, 8PSK is a further step towards increasing the mobile radio data rate. By using the available GSM frame structure, the gross data rate is three times that obtained with GMSK. The CMU 200 can already perform 8PSK on GSM bursts and analyze them thanks to advanced measurement applications. Error vector magnitude and magnitude error have been added to the range of modulation measurements. New templates for power-versus-time measurements ensure compliance with the specifications, as do the modified tolerances for spectrum measurements. 8PSK will transform HSCSD technologies into ECSD and GPRS into EGPRS. As with all other measurements provided by the CMU 200, special attention has been given to achieving maximum measurement accuracy and speed for EDGE too.



GSM 0 TSC detected

	Err. Vect. Magn.	Magn. Error	Phase Error
95th Percentile	1.8 %	1.6 %	1.2 °

		Current	Average	Max / Min
Err. Vect. Magn.	Peak	1.9 %	2.2 %	3.1 %
	RMS	1.0 %	1.1 %	1.2 %
Magn. Error	Peak	1.7 %	2.0 %	- 2.7 %
	RMS	0.7 %	0.8 %	0.9 %
Phase Error	Peak	- 1.6 °	1.6 °	2.0 °
	RMS	0.6 °	0.6 °	0.7 °
Origin Offset		- 54.6 dB	- 58.8 dB	- 52.3 dB
IQ Imbalance		- 60.1 dB	- 58.4 dB	- 51.9 dB
Frequency Error		4 Hz	2 Hz	5 Hz

- 17.1 dBm
Avg. Burst Power (Curr.)

Statistic Count

0.00 %
Bursts out of Tolerance

In the 8PSK mode the modulation analysis is subdivided. The error vector magnitude, the magnitude error and the phase error can be displayed both numerically as shown above, or graphically.

GPRS/EGPRS

Thanks to the new, future-oriented method of packet data transmission, the radio resources of existing GSM mobile radio networks can be utilized efficiently for data services. As with circuit-switched services, GPRS will also use a combination of several timeslots (multislots) and higher-level modulation in the form of 8PSK (EGPRS) to push up the data rate. The introduction of packet-oriented transmission and the associated temporary assignment of radio resources require new test concepts. The CMU 200 provides the following test modes:

- ETSI Test Mode A: In this mode, the mobile is induced to continuously transmit the associated UL timeslots. The CMU 200 can carry out all TX measurements available, such as the power ramp measurement of up to four adjacent timeslots simultaneously, or modulation and spectrum measurements.
- ETSI Test Mode B: This mode creates a loopback in the telephone so that the mobile retransmits data blocks received from the CMU 200. In addition to the measurements available in the ETSI test mode A, test mode B enables bit and block error rate measurements (BER/DBLER).

GSM specifications – Mobile station test

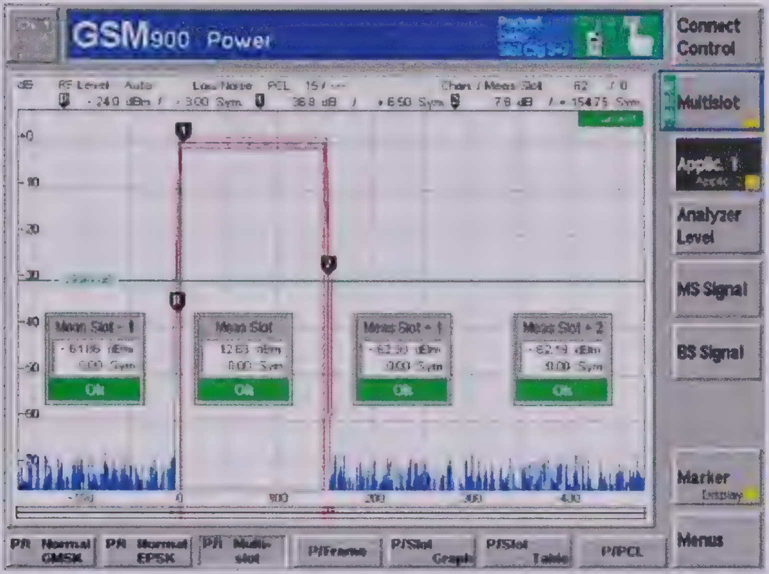
RF generator

Modulation	GMSK, BxT = 0.3 8PSK
Frequency range	
GSM 400 band	460 MHz to 468 MHz / 488 MHz to 496 MHz
GSM850 band	869 MHz to 894 MHz
GSM900 band	921 MHz to 960 MHz
GSM1800 band	1805 MHz to 1880 MHz
GSM1900 band	1930 MHz to 1990 MHz
Attenuation of inband spurious emissions	>50 dB
Inherent phase error (GMSK)	<1° rms <4° peak
Inherent EVM (8PSK)	<2% rms
Frequency settling time	<500 µs to res. phase of 4°
Output level range (GMSK)	
RF1	−130 dBm to −27 dBm
RF2	−130 dBm to −10 dBm
RF3OUT	−90 dBm to +13 dBm
Output level range (8PSK)	
RF1	−130 dBm to −31 dBm
RF2	−130 dBm to −14 dBm
RF3OUT	−90 dBm to +9 dBm
Output level resolution	0.1 dB

Output level uncertainty	+23°C to +35°C	+5°C to +45°C
RF1, RF2 >−117 dBm	<0.5 dB	<0.7 dB
RF3OUT −90 dBm to +10 dBm (GMSK) −90 dBm to +6 dBm (8PSK)	<0.7 dB	<0.9 dB

RF analyzer

Frequency range	
GSM 400 band	450 MHz to 458 MHz / 478 MHz to 486 MHz
GSM850 band	824 MHz to 849 MHz
GSM900 band	876 MHz to 915 MHz
GSM1800 band	1710 MHz to 1785 MHz
GSM1900 band	1850 MHz to 1910 MHz
Measurement bandwidth in measurement menus	500 kHz



The power-versus-time multislot application can graphically display up to 4 adjacent timeslots, automatically detects GMSK- and 8PSK-modulated signals and activates the associated templates in realtime. A new zoom function allows full-screen display of each slot.

Reduced signalling synchronized mode (GPRS)

Extremely fast adjustment and testing of RF parameters during GPRS mobile phone production is ensured by deactivating the GPRS protocol stack. Without using the higher protocol layer (RLC/MAC layer), the CMU 200 synchronizes the mobile (camping), and the data channel (PDCH) is then set up directly.

The GPRS and EGPRS data coders are already available to determine bit error rates (BER) and data block error rates (DBLER).

GSM highlights of CMU 200

Benchmark-breaking IEEE-bus speed

due to

- Parallel measurements
- Secondary addressing
- Optimized processing power

High flexibility for R&D

- Assignment on up to 8 DL slots (TS 0 to 7)
- TX/RX on any transmit slot
- Individual level generation on any DL slot used

GMSK/8PSK measurements

- Phase/frequency error, EVM, magnitude error, origin offset, I/Q imbalance for I/Q modulator tuning
- Power versus time
- On up to 4 UL slots
- Normal/access
- Peak power/average, power versus frame, power versus slot
- General spectrum measurements
- Timing error
- BER/DBLER, RBER/FER, FastBER
- Power versus PCL (on 3 or 7 channels)

Power meter (frequency-selective)

Level range	
RF1	
Continuous power[1]	–40 dBm to +47 dBm (50 W)
Peak envelope power[2] (PEP)	+53 dBm (200 W)
RF2	
Continuous power	–54 dBm to +33 dBm (2 W)
Peak envelope power[2] (PEP)	+39 dBm (8 W)
RF4IN (continuous power and PEP)	–80 dBm to 0 dBm

Level uncertainty	+23°C to +35°C	+5°C to +45°C
RF1, RF2, RF4IN	<0.5 dB	<0.7 dB

Level resolution	0.1 dB (0.01 dB via remote control)

Modulation analysis

Level range (PEP)	
RF1 [2]	–6 dBm to +53 dBm
RF2 [2]	–20 dBm to +39 dBm
RF4IN	–60 dBm to 0 dBm
Inherent phase error (GMSK)	<0.6°, rms <2°, peak
Inherent EVM (8PSK)	<1,0 %, rms
Frequency measurement uncertainty	≤10 Hz + drift of time base

Burst power measurement

Reference level for full dynamic range (GMSK, low noise mode)	
RF1 [2]	+10 dBm to +53 dBm
RF2 [2]	–4 dBm to +39 dBm
RF4IN	–22 dBm to 0 dBm
Dynamic range (GMSK)	>72 dB (BW=500 kHz, rms)
Reference level for full dynamic range (8PSK, low noise mode)	
RF1 [2]	+6 dBm to +49 dBm
RF2 [2]	–8 dBm to +35 dBm
RF4IN	–26 dBm to –4 dBm
Dynamic range	>69 dB (BW = 500 kHz, rms)
Relative measurement uncertainty	
Result > –40 dB	<0.1 dB
–60 dB ≤result≤–40 dB	<0.5 dB
Resolution	0.1 dB in active part of burst

---

[1] *50 W from +5 °C to +30 °C, linear degradation down to 25 W at 45 °C.*

[2] *Mean value of power versus time must be equal or less than allowed continuous power.*

TDMA in CMU 200

The need for higher data rates is the trend in our information-oriented society in the new millennium. The enhancement of mobile phones takes this need into account on the way to the next generation of wireless communication. Need to test these future improvements?

The CMU 200 does it all. The TDMA section takes care of your requirements to cope with this fast progressing mobile technology. The CMU 200 concept with its multistandard platform architecture provides for further extensions such as *Bluetooth* and cdma2000.

[illegible]

The wide acceptance of TDMA (IS-136) is based on its very flexible and powerful technology, as well as on its compatibility with AMPS, which is widespread and one of the major wireless communication standards. Derived from analog AMPS, the TDMA standard is now ready for a step-by-step evolution into the third generation of mobile radio technology. This fact shows the need for a test instrument that is flexible enough to cover all future needs as well as the current standards.

For TDMA (IS-136) signalling functionality, the CMU 200 requires the versatile signalling unit (CMU-B21) as well as the software option CMU-K27 for the cellular band or CMU-K28 for the PCS band

Due to the highly user-friendly menu concept, the CMU 200 provides quick access to all measurements desired, optimizing handling and consequently efficiency.

Signalling mode

The CMU 200 simulates a TDMA base-station RF interface including the signalling protocol so that a mobile can be tested with regard to different signalling parameters. All necessary network and base-station parameters can be set, such as control and traffic channel configuration, neighbouring channels setup etc. You can also generate a MAHO report.

Non-signalling mode

The non-signalling mode is for generating and analyzing TDMA (IS-136) signals in the frequency range from 10 MHz to 2.7 GHz. The CMU 200 provides TDMA-specific measurements such as:

- Power
- Modulation
- Spectrum
- Power versus time
- BER

TDMA (IS-136) development

With its great versatility the CMU 200 is the most suitable tool for the development of mobile phones. Four configurable RF connectors are provided to enable flexible signal generation and analysis. The power meter can evaluate signals in a range from –80 dBm to + 47 dBm, whereas the generator outputs signals from –130 dBm to +13 dBm. The clearly structured and user-friendly menu design together with the clear-cut screen layout provides quick access to all features and ensures trouble-free monitoring of the device under test.

Quality assurance

Due to its high measurement repeatability and accuracy, the CMU 200 is the right choice to ensure a consistently high quality standard in production. TDMA-specific measurements such as BER, error vector magnitude (EVM) and EVM10, where only the first 10 symbols are taken into account, provide an excellent test platform to guarantee the production of high-quality devices.

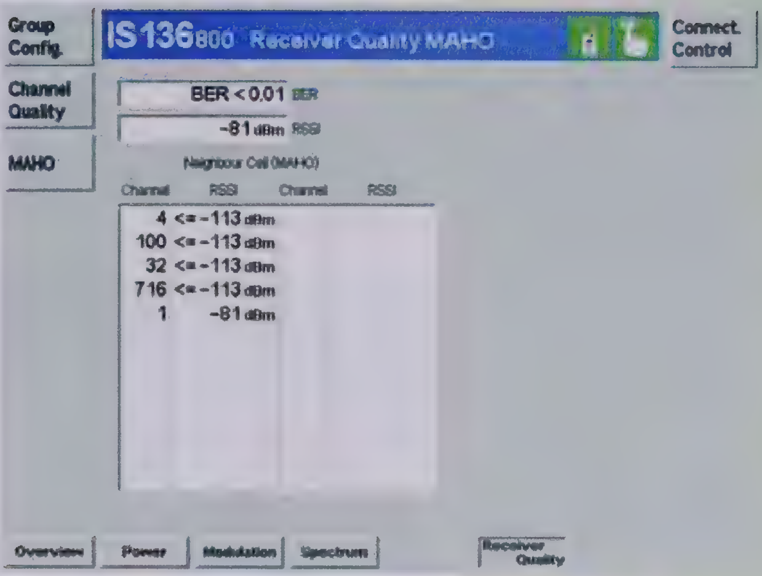
Production of mobile phones

The production of mobile phones requires time-efficient and cost-effective means that ensure both high throughput and state-of-the-art accuracy. Thanks to the unique IEC/IEEE-bus concept of the CMU 200, these two goals can be easily achieved in your production line. The intelligent handling of the GPIB commands received optimizes the measurement speed for all TDMA-specific measurements. In practice, this will mean dramatically enhanced test time and test yield.

Acoustic measurements

The newly implemented ACELP speech coder is able to encode and decode real audio signals and allows you to use the CMU 200 also in real acoustic measurement applications. Equivalent to the GSM implementation of the CMU 200 the TDMA speech coder provides analog inputs and outputs and a connector for an external handset. The speech coder requires the hardware option CMU-B52 and can also be combined with the internal Audio Analyzer/Generator CMU-B41.

The mobile reports the received signal strength (RSSI) of the observed channels back to the CMU where the RSSI is displayed in the MAHO report list. It is possible to configure the neighbouring channels in the network setup. The reported BER can also be monitored.


Group Config.
IS136 800 Receiver Quality MAHO
Connect. Control
Channel Quality
MAHO
Overview
Power
Modulation
Spectrum
Receiver Quality

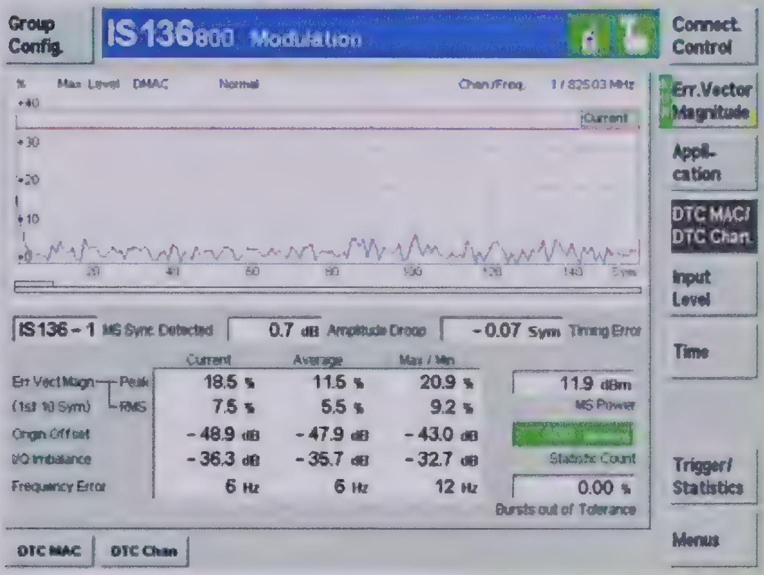
BER < 0.01 BER

-81 dBm RSSI

Neighbour Cell (MAHO)

Channel	RSSI	Channel	RSSI
4	<= -113 dBm		
100	<= -113 dBm		
32	<= -113 dBm		
716	<= -113 dBm		
1	-81 dBm		

The modulation menu allows the phase error, frequency error and the error vector magnitude to be measured. The measurement results are displayed graphically. Additional measurements such as amplitude droop and timing error are taken as well and displayed numerically in the same screen.


Group Config.
IS136 800 Modulation
Connect. Control
%
Max. Level DMAC
Normal
Chan./Freq. 1 / 825.03 MHz
+40
Current
+30
+20
+10
+0
20
40
60
80
100
120
140
Sym
Err.Vector Magnitude
Appli-cation
DTC MAC/ DTC Chan.
Input Level
Time
Trigger/ Statistics
Menus
DTC MAC
DTC Chan

IS136 - 1 MS Sync Detected

0.7 dB Amplitude Droop

- 0.07 Sym Timing Error

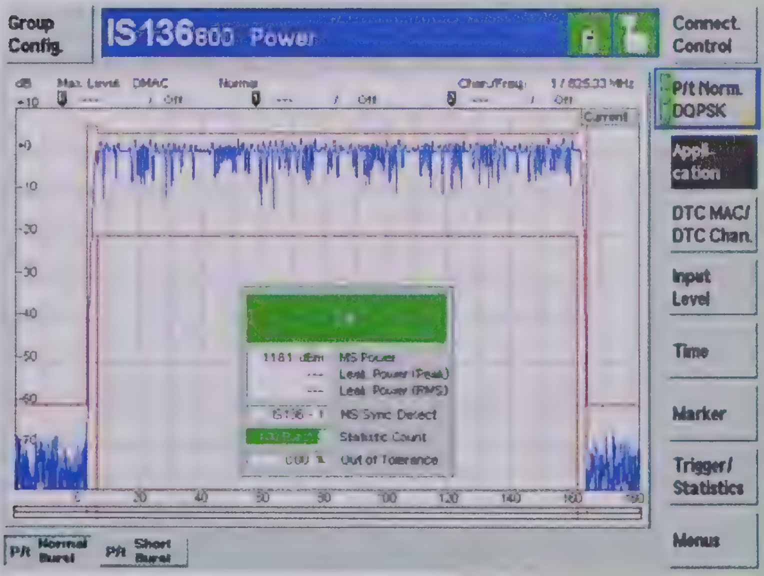
		Current	Average	Max / Min
Err Vect Magn (1st 10 Sym)	Peak	18.5 %	11.5 %	20.9 %
	RMS	7.5 %	5.5 %	9.2 %
Origin Offset		- 48.9 dB	- 47.9 dB	- 43.0 dB
I/Q Imbalance		- 36.3 dB	- 35.7 dB	- 32.7 dB
Frequency Error		6 Hz	6 Hz	12 Hz

11.9 dBm MS Power

Statistic Count

0.00 % Bursts out of Tolerance

In the power menu, the mobile output power of the short burst or the normal burst is displayed. The CMU200 also enables leakage power measurements which indicate the mobile power output in time slots not used.


Group Config.
IS136 800 Power
Connect. Control
dB
Max. Level DMAC
Normal
Chan./Freq. 1 / 825.03 MHz
Off
Current
+10
+0
-10
-20
-30
-40
-50
-60
-70
0
20
40
60
80
100
120
140
160
180
P/t Norm. DQPSK
Appli-cation
DTC MAC/ DTC Chan.
Input Level
Time
Marker
Trigger/ Statistics
Menus
P/t Normal Burst
P/t Short Burst

11.81 dBm MS Power

--- Leak. Power (Peak)

--- Leak. Power (RMS)

IS136 - 1 MS Sync Detect

Statistic Count

0.00 % Out of Tolerance

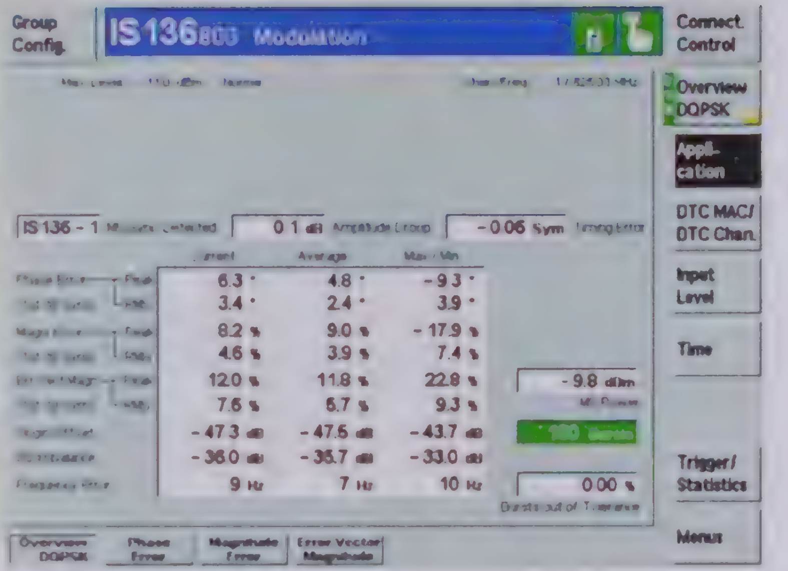
TDMA in CMU200

Handoffs

Handoffs are part of the IS-136 specification. Handoffs between PCS and cellular bands as well as from and to AMPS are defined and have to be tested. The CMU 200 supports handoffs from IS-136 800 MHz to 1900 MHz (inter-band handoff) and vice versa. Handoffs from 1900 MHz or 800 MHz to AMPS and vice versa are also possible (inter-mode handoff) with the CMU 200.

Switching standards

The flexibility of the CMU 200 makes for quick and simple switching between two different standards. This is very important for IS-136 which is a dual-mode standard containing a digital (TDMA) and an analog mode (AMPS). The handoff between TDMA and AMPS can be achieved by simply pressing a button. This results in a very versatile test concept to improve the flexibility and throughput of your production line.



IS 136 - 1 | 0.1 dB | -0.06 Sym

	Current	Average	Max / Min
	6.3 °	4.8 °	-9.3 °
	3.4 °	2.4 °	3.9 °
	8.2 %	9.0 %	-17.9 %
	4.6 %	3.9 %	7.4 %
	12.0 %	11.8 %	22.8 %
	7.6 %	6.7 %	9.3 %
	-47.3 dB	-47.6 dB	-43.7 dB
	-36.0 dB	-35.7 dB	-33.0 dB
	9 Hz	7 Hz	10 Hz

-9.8 dBm

0.00 %

In the modulation overview menu, error vector magnitude (EVM), phase error and magnitude error are measured simultaneously and displayed in a numerical table. It is possible to choose either EVM, where the whole burst is considered, or EVM10, where only the first ten symbols are taken into account.

TDMA specifications – Mobile station test

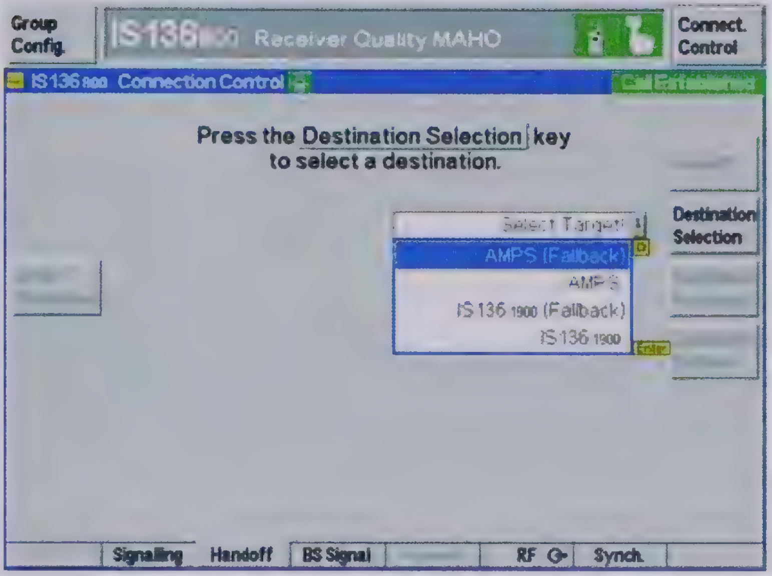
[illegible]

Frequency range signalling mode	
US Cellular	869 MHz to 894 MHz
PCS (US)	1930 MHz to 1990 MHz
Frequency range non-signalling mode	10 MHz to 2200 MHz
Frequency resolution	1 Hz
Frequency uncertainty	same as time base
Output level range	
RF1	–130 dBm to –32 dBm
RF2	–130 dBm to –15 dBm
RF3OUT	–90 dBm to +8 dBm
Output level resolution	0.1 dB
Output level uncertainty	see CMU 200 base unit

Modulation	
π/4 DQPSK or unmodulated (non signalling mode)	
Uncertainty	<2.5% (EVM rms)
Carrier suppression	>40 dB

RF analyzer

Frequency range signalling mode	
US Cellular	824 MHz to 849 MHz
PCS (US)	1850 MHz to 1910 MHz
Frequency range non-signalling mode	10 MHz to 2200 MHz
Frequency resolution	1 Hz
Frequency uncertainty	same as time base
Modulation analyzer	
824 MHz to 849 MHz and 1850 MHz to 1910 MHz	
EVM, rms (residual)	<2%
EVM, peak (residual)	<4%
I/Q offset (residual)	<–50 dB (0.3%)
I/Q imbalance (residual)	<–50 dB (0.3%)
Frequency measurement range	–2 kHz to +2 kHz
Frequency measurement error	≤5 Hz + drift of time base


Group Config.
IS136 800 Receiver Quality MAHO
Connect. Control
IS136 800 Connection Control
Select Target
AMPS (Fallback)
AMPS
IS136 1900 (Fallback)
IS136 1900
Enter
Destination Selection
Signalling
Handoff
BS Signal
RF
Synch.

Press the Destination Selection key
to select a destination.

Handoffs from cellular band (800 MHz) to PCS band (1900 MHz) can be tested as well as to and from AMPS. Before handing off to a new network the parameters for the target network can be set. This results in a large variety of different test scenarios.

Power meter (frequency-selective)

Level uncertainty	see CMU200 base unit

Power versus time measurement

Reference level for full dynamic range (low noise mode)	
RF1	+4 dBm to +47 dBm
RF2	–10 dBm to +33 dBm
RF4IN	–28 dBm to –6 dBm
Dynamic range	>74 dB (BW=100 kHz, rms)
Relative measurement uncertainty	
Result >–40 dB	<0.1 dB
–60 dB≤ result ≤–40 dB	<0.5 dB
Residual leakage power level	<–65 dBm
Adjacent channel power measurement	
Dynamic range	
1st adjacent channel	>45 dB
2nd and 3rd adjacent channel	>55 dB

TDMA highlights of CMU 200

Basic features

- Call to / from mobile
- Handoff to AMPS
- Dual-band handoff

Signalling measurements

- MAHO report
- Power versus time
  - Short burst
  - Normal burst
- Modulation
  - Phase error
  - Magnitude error
  - EVM/EVM10
  - Overview of phase / magnitude and EVM simultaneously
- Spectrum
  - Adjacent channel power due to switching/due to modulation
- Overview
  - Signalling information

Non-signalling measurements

- Modulation
- Spectrum
- Power versus time
- BER

AMPS in CMU200

AMPS overview

Analog AMPS (advanced mobile phone system) is a standard system for analog cellular telephone service in the United States and is also used in other countries. It is based on the frequency spectrum allocation for cellular service by the Federal Communications Commission (FCC) in 1970. Introduced by AT&T in 1983, AMPS became the most widely deployed cellular system in the United States.

AMPS options

Although AMPS is a 1st generation analog standard, a great demand for mobile radio testers covering this standard will continue to exist in the future. Especially in the United States, dual-mode cdmaOne/AMPS and TDMA/AMPS phones are very common. By combining the digital standards with analog AMPS, the network operators offer their customers the advantages of the digital standards and ensure nearly 100% coverage in North America. As a consequence, Rohde & Schwarz is extending the range of the CMU 200 options by introducing analog AMPS in addition to the digital standards TDMA, cdmaOne and CDMA2000. These options add analog AMPS functionality to the CMU 200 base unit:

- CMU-B21 (versatile link handler)
- CMU-B41 (audio generator analyzer)
- CMU-K29 (AMPS test software)

The hardware options CMU-B21 (versatile link handler) and CMU-B41 (audio generator/analyzer) are suited for other standards as well.

AMPS measurements and features

As for other standards, there are two categories of AMPS measurements:

- Transmitter tests for verifying the transmit part of a mobile
- Receiver tests for verifying the receive part of a mobile
- AF level search routine
- Sensitivity search routine

The AF level search routine in the TX test menu allows the user to set the desired frequency deviation of the mobile transmitter at a keystroke, the level of the CMU 200 modulation generator being automatically corrected.

The Sensitivity search routine in the RX test menu automatically searches the receiver input level at which a selectable SINAD of the demodulated signal can still be attained. The following list provides an overview of the most important tests implemented in the CMU-K29 option.

Transmitter measurements

- Carrier power
- Carrier frequency error
- SAT frequency error/peak deviation
- ST frequency error/peak deviation
- Modulation noise and distortion
- Hum and noise
- Electrical audio frequency response
- Modulation distortion
- Residual AM

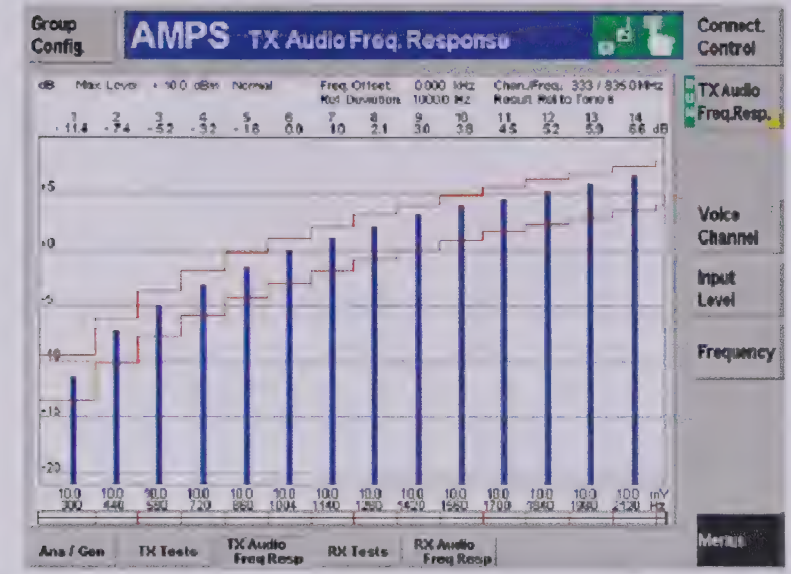
Receiver measurements

- Sensitivity
- Hum and noise
- SINAD
- Distortion
- AF voltage
- Electrical audio frequency response
- Residual AM
- Audio deviation

AMPS specifications – Mobile station test

RF generator

Frequency range signalling mode	
[illegible]	[illegible] MHz to 894 MHz
Frequency range non-signalling mode	10 MHz to 2200 MHz
Frequency resolution	1 Hz
Frequency uncertainty	same as time base
Output level range	
RF1	–130 dBm to –27 dBm
RF2	–130 dBm to –10 dBm
RF3OUT	–90 dBm to +13 dBm
Output level resolution	0.1 dB
Output level uncertainty	see CMU 200 base unit (add 0.1 dB)
Modulation	
FM deviation range	100 Hz to 20 kHz
FM resolution	1 Hz
AF range	100 Hz to 15.999 kHz


Group Config
AMPS TX Audio Freq. Response
Connect. Control
dB Max Level +10.0 dBm Normal
Freq. Offset 0.000 kHz
Ref. Deviation 1000.0 Hz
Chan./Freq. 333 / 835.0 MHz
Result Rel to Tone 6
1 2 3 4 5 6 7 8 9 10 11 12 13 14
-11.4 -7.4 -5.2 -3.2 -1.8 0.0 1.0 2.1 3.0 3.8 4.5 5.2 5.9 6.6 dB
+5
+0
-5
-10
-15
-20
10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 mV
300 440 580 720 860 1004 1140 1280 1420 1560 1700 1840 1980 2120 Hz
TX Audio Freq.Resp.
Voice Channel
Input Level
Frequency
Menus
Ana / Gen
TX Tests
TX Audio Freq Resp
RX Tests
RX Audio Freq Resp

TX audio frequency response measurement: the pre-emphasis characteristic of the mobile transmitter is verified by a single-shot measurement

All the filters required for the measurements are of course preconfigured in line with specifications, but their settings can be modified for individual measurements. The RX and TX electrical audio frequency response measurements in AMPS are usually defined as frequency sweep versus AF frequency range. The CMU 200 offers a much faster and more modern alternative. Using the TX and RX audio frequency response menus of the CMU 200, the AF frequency response is measured simultaneously at 20 test points with user-programmable level and frequency and then checked against specified tolerances (see screenshot above).

AMPS highlights of CMU200

Benefits of base unit

- Platform supporting cdmaOne, CDMA2000, TDMA and AMPS within one box
- Wide frequency range allowing dual mode/dual band testing required for cdmaOne, CDMA2000 and TDMA
- See base unit section

AMPS features

- Powerful signalling capabilities
- Base station simulation
- Mobile or base station originated call connect/disconnect
- Short measurement time ensuring high throughput
- Combined measurements
- Benchmark-breaking IEEE-bus speed (see GSM highlights)
- Simple interactive operation, standardized MMI
- No specialized network knowledge required
- Various handoffs from cdmaOne, CDMA2000/TDMA and to TDMA supported

FM distortion (SINAD; dev. 8 kHz, AF 1 kHz, BW 30 Hz to 15 kHz)	≥40 dB
Residual FM (rms, BW 300 Hz to 3 kHz)	≤10 Hz
Deviation uncertainty at 1 kHz AF, 8 kHz dev.(measurement bandwidth 30 Hz to 15 kHz)	<2 % of setting + residual FM
Deviation frequency response at 300 Hz to 15.999 kHz AF	≤1 dB

RF analyzer

Frequency range signalling mode	
US Cellular	824 MHz to 849 MHz
Frequency range non-signalling mode	10 MHz to 2200 MHz
Frequency resolution	1 Hz
Frequency uncertainty	same as time base

Power meter (frequency-selective)

Reference level range	
RF1	0 dBm to +53 dBm
RF2	–14 dBm to +39 dBm
RF4IN	–37 dBm to 0 dBm
Level uncertainty	see CMU200 base unit
Level resolution	0.1 dB

FM measurement

Dynamic range	30 dB below reference level
RF bandwidth (2 x deviation + 4 x AF)	136 kHz
Deviation range	0 kHz to 47 kHz
Resolution	1 Hz
AF range	100 Hz to 18 kHz
Residual FM	
BW 300 Hz to 3 kHz, rms	≤5 Hz
BW 6 Hz to 20 kHz, rms	≤18 Hz
Uncertainty (BW 6 Hz to 20 kHz)	<1% of reading + residual FM
Carrier frequency error measurement range	–47 kHz to +47 kHz
Carrier frequency error measurement uncertainty	≤2 kHz + drift of time base

AF generator

see CMU200 base unit (Audio Analyzer/Generator CMU-B41)

AF analyzer

see CMU200 base unit (Audio Analyzer/Generator CMU-B41)

cdmaOne in CMU 200

CDMA overview

Code division multiple access (CDMA) – once a radically new concept in wireless communication – has meanwhile become a well established standard in the world of mobile communication. CDMA has proven its advantages and capabilities and has gained widespread international acceptance.

Instead of using frequencies or timeslots as traditional technologies like TDMA and AMPS do, CDMA uses mathematical codes to transmit and distinguish between multiple wireless conversations. Depending on the level of mobility, CDMA provides 8 to 10 times the capacity of AMPS and 4 to 5 times the capacity of TDMA systems. CDMA can efficiently utilize the spectrum and serve many subscribers without requiring extensive frequency planning.

History

Since the startup of the first commercial CDMA network in Hong Kong in September 1995, CDMA has established itself as a worldwide mobile radio standard. It has not only been successful in its country of origin, the USA, as well as in Korea and Japan, but all over the world. With its still booming growth rates CDMA today is – besides GSM – one of the most important digital 2nd generation mobile radio standards. CDMA is therefore also suited as the leading-edge technology on the way to 3rd generation mobile radio.

cdmaOne options

Taking the current development on the market into account, Rohde & Schwarz has extended the proven modular concept of the CMU 200 with cdmaOne functionality. The following options make the CMU 200 a compact radio communication tester for all TIA/EIA-95-based cdmaOne mobile phones:

- CMU-B81 (cdmaOne signalling unit)
- CMU-K81 (cdmaOne test software for cellular band)
- CMU-K82 (cdmaOne test software for PCS band)

The CMU 200 is also the first choice as a tester for cdmaOne – especially in harsh production environments – because of its outstanding measurement speed, ultra-high accuracy and unrivalled reliability which is also a result of the innovative ventilation concept. Thanks to the modular concept of the CMU 200, cdmaOne functionality plus GSM, TDMA (TIA/EIA-136), AMPS and other standards such as *Bluetooth* can be implemented in a single unit. Which other radio communication tester can boast such superior features?

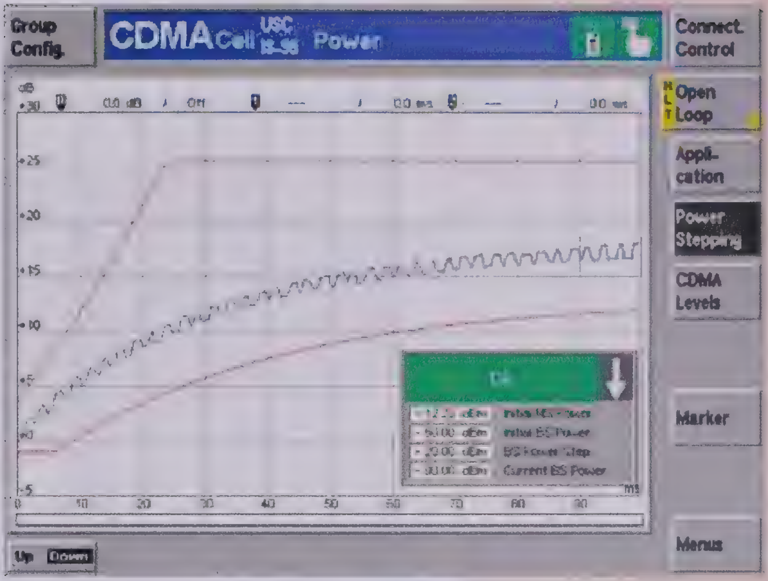
cdmaOne functionality

In cdmaOne mode, the tests are based on the TIA/EIA-95A, TSB-74, and J-STD-008 cdmaOne airlink standards. In addition, the cdmaOne option supports also the standards ARIB-T53 and Korean PCS. The tester emulates a code division multiple access base station, makes a call to the mobile, and tests all essential parameters of a cdmaOne mobile station. The tester can measure the following key parameters among other tests:

- Power measurements:
  - Open-loop time response
  - Gated output power
  - Minimum output power
  - Maximum output power
  - Sideband suppression
- Receiver quality measurements:
  - Frame error rate (FER)
  - Built-in AWGN generator for simulating environmental noise
  - Predefined configurations for sensitivity and dynamic range
- Transmitter quality measurements:
  - Waveform quality
  - Error vector magnitude
  - Phase error
  - Magnitude error
  - Carrier feedthrough and I/Q imbalance
  - Frequency accuracy
- Handoffs:
  - RF channel
  - CDMA interband
  - Handoff to AMPS
  - PN offset
  - Frame offset
- Non-signalling measurements:
  - Power
  - Waveform quality
  - Frequency error
  - Carrier feedthrough
  - I/Q imbalance

All measurements are implemented according to test specification IS-98C. Parameters and limits are predefined to meet the IS-98C test requirements. This allows easy pass/fail decisions without the need of reconfiguring the test setup.

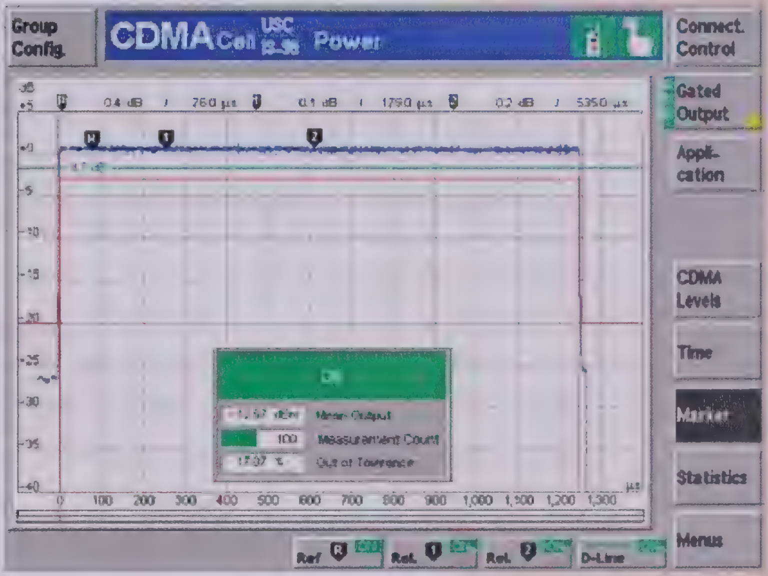
Graphical representation of transmitter measurements such as open-loop time response, gated output power and modulation are helpful tools especially in R&D environments.


Group Config.
CDMA Cell USC IS-98 Power
Connect. Control
Open Loop
Appli- cation
Power Stepping
CDMA Levels
Marker
Menus
dB
0.0 dB / Off
0.0 ms
0.0 ms
OK
ms
Up
Down

Initial MS Power
Initial BS Power
BS Power Step
Current BS Power

Open-loop time response

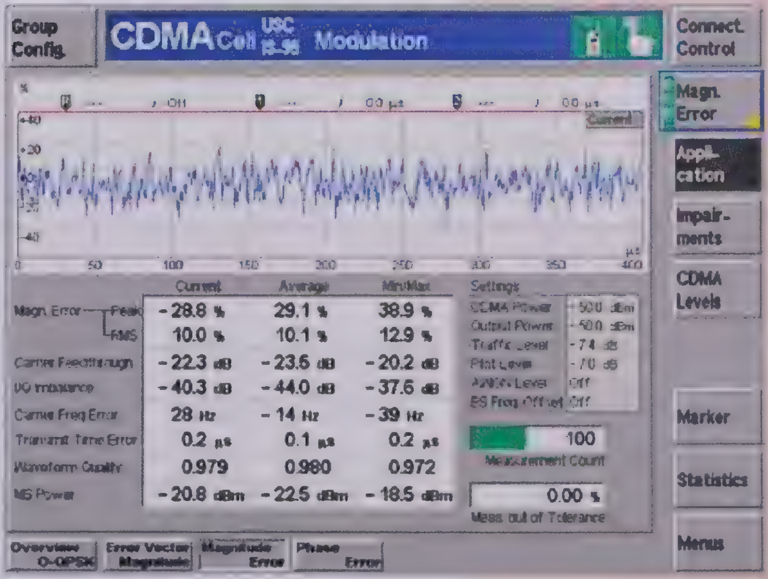
The open-loop power control test shows the response of the mobile station to an increase or decrease in base-station total power. The default increase or decrease for this test is 20 dB. Power stepping and cdmaOne levels are user-definable.


Group Config.
CDMA Cell USC IS-98 Power
Connect. Control
Gated Output
Appli- cation
CDMA Levels
Time
Marker
Statistics
Menus
dB
0.4 dB / 76.0 µs
0.1 dB / 179.0 µs
0.2 dB / 535.0 µs
OK
µs
Ref
Rel.
Rel.
D-Line

Mean Output
100 Measurement Count
Out of Tolerance

Gated output power

The gated output power can be displayed in several formats. Select FULL DISPLAY to show the total period of the IS-98 gated output template. The period of the full display is approx. 1500 µs. Select RISING EDGE or FALLING EDGE to zoom in to display the 17 ms period of the rising or falling edge of the waveform. In each of these displays, a MARKER can be activated to display both power amplitude and relative time.


Group Config.
CDMA Cell USC IS-98 Modulation
Connect. Control
Magn. Error
Appli- cation
Impair- ments
CDMA Levels
Marker
Statistics
Menus
%
Off
0.0 µs
0.0 µs
Current
µs
Overview O-QPSK
Error Vector Magnitude
Magnitude Error
Phase Error

		Current	Average	Min/Max
Magn. Error	Peak	- 28.8 %	29.1 %	38.9 %
	RMS	10.0 %	10.1 %	12.9 %
Carrier Feedthrough		- 22.3 dB	- 23.6 dB	- 20.2 dB
I/Q Imbalance		- 40.3 dB	- 44.0 dB	- 37.6 dB
Carrier Freq Error		28 Hz	- 14 Hz	- 39 Hz
Transmit Time Error		0.2 µs	0.1 µs	0.2 µs
Waveform Quality		0.979	0.980	0.972
MS Power		- 20.8 dBm	- 22.5 dBm	- 18.5 dBm

Settings	
CDMA Power	- 50.0 dBm
Output Power	- 50.0 dBm
Traffic Level	- 7.4 dB
Pilot Level	- 7.0 dB
AWGN Level	Off
BS Freq Offset	Off

100
Measurement Count

0.00 %
Meas. out of Tolerance

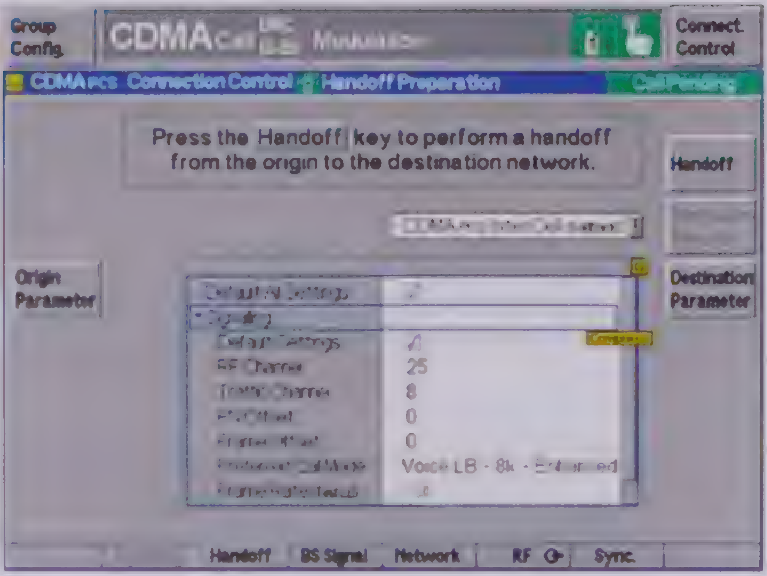
Modulation measurements: magnitude error

Modulation measurements serve for assessing the quality of the mobile's transmit part. In addition to phase error, error vector magnitude and magnitude error can be shown graphically at the push of a button. A clearly arranged table lists carrier feedthrough, I/Q imbalance, frequency error and waveform quality with current measurement results, average and minimum/maximum values.

cdmaOne in CMU 200

CDMA know-how

Rohde & Schwarz is not a newcomer in the field of CDMA, but has many years of experience. As early as 1996, Rohde & Schwarz and Tektronix launched a professional radio tester for cdmaOne mobiles. This extremely successful tester was sold thousands of times worldwide and has undergone permanent enhancement and adaptation to remain state-of-the-art. The CMU 200 builds on this success and is able to perform cdmaOne mobile station tests using thoroughly proven test and measurement methods, and also offers the possibility of enhancement for future technologies.



Press the Handoff key to perform a handoff from the origin to the destination network.

RF Channel	25
Traffic Channel	8
[illegible]	0
[illegible]	0
[illegible]	Voice LB - 8k - Enhanced

The CMU 200 offers a separate menu for handoffs. In addition to handoff targets such as operating status or network to which the CMU 200 is to switch, the required target parameters, e.g. channel number etc. can be configured. This enables handoff to AMPS as well as handoff to and from the voice loopback mode.

TIA
MEMBER

cdmaOne specifications – Mobile station test

Standards	
cdmaOne standards	TIA/EIA 95, J-[illegible] [illegible] Chinese
cdmaOne test standards	TIA/EIA-98, J-STD-018

RF generator

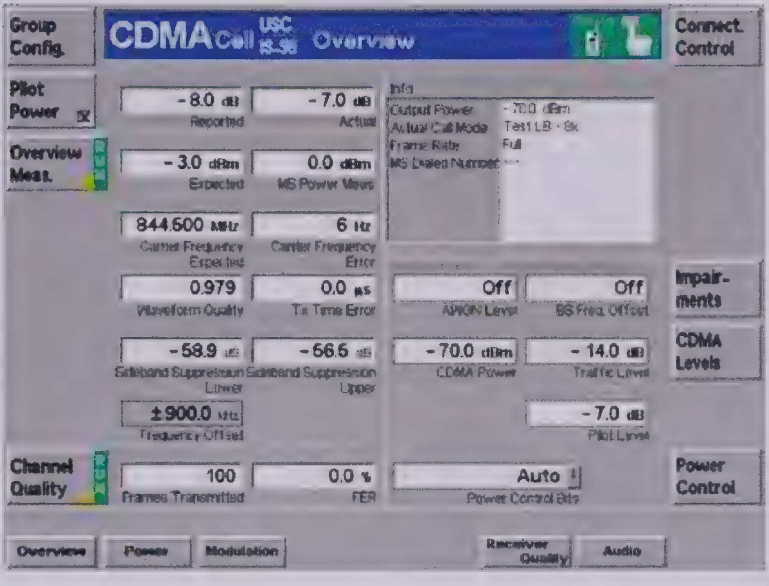
Frequency range	
Option CMU-K81	
US Cellular	869 MHz to 894 MHz
China Cellular	934 MHz to 969 MHz
Japan Cellular	832 MHz to 870 MHz
Option CMU-K82	
PCS (US)	1930 MHz to 1990 MHz
PCS (Korea)	1805 MHz to 1870 MHz
Frequency resolution	channel spacing according to standard
Frequency uncertainty	same as time base
Output level range (modulated signal)	
RF1	–120 dBm to –33 dBm
RF2	–120 dBm to –16 dBm
RF3OUT	–80 dBm to +4 dBm
Output level resolution (modulated signal)	0.1 dB

Output level uncertainty		
	+23°C to +35°C	+5°C to +45°C
RF1, RF2 ≥ –108 dBm	<0.5 dB	<0.7 dB
RF3OUT –80 dBm to +4 dBm	<0.7 dB	<0.9 dB

Modulation	
QPSK, multiple QPSK	1.2288 Mcps
AWGN	see AWGN generator
Carrier suppression	>35 dB
Waveform quality factor (ρ)	>0.985
AWGN generator	
Selectable bandwidth	1.23 MHz or 1.8 MHz
Output level resolution	0.1 dB

RF analyzer

Frequency range	
Option CMU-K81	
US Cellular	824 MHz to 849 MHz
China Cellular	889 MHz to 924 MHz
Japan Cellular	887 MHz to 925 MHz
Option CMU-K82	
PCS (US)	1850 MHz to 1910 MHz
PCS (Korea)	1715 MHz to 1780 MHz
Measurement filter	according to standard (1.23 MHz bandwidth)



-8.0 dB Reported
-7.0 dB Actual
-3.0 dBm Expected
0.0 dBm MS Power Meas.
844.600 MHz Carrier Frequency Expected
6 Hz Carrier Frequency Error
0.979 Waveform Quality
0.0 µs Tx Time Error
-58.9 dB Sideband Suppression Lower
-66.6 dB Sideband Suppression Upper
±900.0 kHz Frequency Offset
100 Frames Transmitted
0.0 % FER

Info
Output Power -70.0 dBm
Actual Call Mode Test1 LB - 8k
Frame Rate Full
MS Dialed Number ---

Off AWGN Level
Off BS Freq. Offset
-70.0 dBm CDMA Power
-14.0 dB Traffic Level
-7.0 dB Pilot Level
Auto Power Control Bits

The overview menu shows the most important parameters in a clear form. These include BS settings as well as MS test results such as power, frequency error and waveform quality. The overview menu also gives access to other tests (power control, modulation, receiver quality).

Frequency resolution	channel spacing according to standard
Level range (O-QPSK signal)	
RF1	–40 dBm to +47 dBm
RF2	–54 dBm to +33 dBm
RF4IN	–80 dBm to –6 dBm

Power meter (frequency-selective)

Level uncertainty

	+23°C to +35°C	+5°C to +45°C
RF1, RF2, RF4IN	<0.5 dB	<0.7 dB

Level resolution	0.1 dB

Modulation analyzer

ρ uncertainty (for ρ 0.9 to 1)	<0.003
Frequency measurement range	–3 kHz to +3 kHz
Frequency measurement uncertainty	≤30 Hz + drift of timebase
Timing measurement uncertainty	<60 ns

cdmaOne highlights of CMU200

- Voice loopback and comprehensive testing of mobiles
- Powerful signalling capabilities
- Built-in AWGN generator for simulating environmental noise
- Base station simulation
- Mobile or base station originated call connect/disconnect
- Short measurement time ensuring high throughput
- Combined measurements (RX/TX in parallel)
- Benchmark-breaking IEEE-bus speed (see GSM highlights)
- Simple interactive operation, standardized MMI
- No specialized network knowledge required
- Various handoffs supported (e.g. cdmaOne to analog AMPS)
- Dual-band/dual-mode testing
- Signalling and non-signalling mode
- Support of GPSOne test application

Supported CDMA standards

Frequency band	**Airlink standard**
US Cellular (800 MHz)	TIA/EIA-95
Japan Cellular	ARIB-T53/-95
China Cellular	TIA/EIA-95
US PCS (1900 MHz)	ANSI-J-STD008, UB-IS-95
Korea PCS (1800 MHz)	J-STD008, UB-IS-95

CDMA2000-1X in CMU 200

[illegible]

CDMA2000 arose from the further development of cdmaOne (TIA/EIA-95) and is an enormous step towards 3G. Besides higher data rates and considerably improved efficiency, CDMA2000 is particularly noteworthy for its downward compatibility to cdmaOne. Nine different configurations (radio configurations RC1 to RC9) in the forward link and six radio configurations in the reverse link define the different connections which are specified in the IS-2000 standard.

- RC1 and RC2 define cdmaOne connections for rate set 1 and rate set 2
- RC3 to RC5 in the forward link (or RC3 to RC4 in the reverse link) define CDMA2000 connections for spreading rate 1 (CDMA2000-1X)
- RC6 to RC9 in the forward link (or RC5 to RC6 in the reverse link) define CDMA2000 connections for spreading rate 3 (CDMA2000-3X) mc

Compared to cdmaOne, CDMA2000-1X doubles the capacity for pure voice transmission and provides a maximum packet data rate of 307 kbps on a single 1.25 MHz carrier. CDMA2000-1X is a recognized IMT-2000 3G standard, already successfully established in Korea – and will soon be implemented in Japan, the USA, Canada, Mexico and Brazil. Its application in Eastern Europe is planned as well.

[illegible]

The CDMA2000 standards have been implemented together with our proven alliance partner Tektronix. By supporting the CDMA2000 standard, Rohde & Schwarz consequently enhances the functionality of the CMU 200 multimode platform.

The central component of the CDMA2000-1X option is the Signalling Unit CMU-B83, which is a prerequisite for enabling the CDMA2000-1X functionality in the CMU 200. The CMU-B83 is designed for maximum conformity to the standard. The CMU-B83, of course, does not only support pure CDMA2000-1X high-speed data links, but also enables the links of the previous TIA/EIA-95A/B standards.

All tests, which could be performed with the cdmaOne option in conjunction with the CMU-B81, are also available in the new CDMA 2000 option. The CMU-U83 option is a cost-efficient upgrade solution from Rohde & Schwarz for customers who have already acquired the cdmaOne option in the CMU 200.

CDMA2000-1X is used in diverse frequency ranges. The standard currently defines ten different band classes all of which are supported by the CMU 200 with its universal hardware concept.

The following options are available for CDMA2000-1X.

- CMU-B83: CDMA2000 signalling unit (essential)
- CMU-U83: cost-efficient hardware upgrade from CMU-B81 to CMU-B83
- CMU-U65: 3G DDC (additional DSP for the digital board, essential)
- CMU-K83: CDMA2000-1X software for the 450 MHz band (band class 5)
- CMU-K84: CDMA2000-1X software for cellular bands
- CMU-K85: CDMA2000-1X software for PCS bands
- CMU-K86: CDMA2000-1X software for IMT2000 band (band class 6)

The universal hardware and software concept of the CMU 200 represents the optimum solution for the future development and challenges of the CDMA standard over the next few years.

CDMA2000-1X functionality

The similarities with cdmaOne (same physical conditions and downward compatibility) make the CDMA2000-1X T&M concept very similar to that of cdmaOne. There are, however, major differences in the protocols.

The CMU 200 supports connections in all radio configurations defined for CDMA2000-1X, i.e. TIA/EIA-95 connections as well as the usual CDMA2000-1X high-speed connections.

Code domain power is a new and highly important measurement for mobile phones in CDMA2000. Since several code channels are now transmitted simultaneously in the reverse link, it is necessary to check whether the power distribution of the different channels complies with the test specification (TIA/EIA-IS-98-D) for CDMA2000. The measurement concept in the CMU 200 is based on ProbeDSP™ technology, which permits high-speed measurement of the code domain power. The emphasis is on fast measurements and clear and concise representation.

Of course, the CMU 200 also supports the requirements placed on the gpsOne test application; the CMU 200 meets the high demands for frequency and phase accuracy.

The CDMA2000-1X implementation in the CMU 200 is based on the TIA/EIA IS-2000 Rev. 0 standard; the measurements comply with the TIA/EIA IS-98-D standard.

The CMU200 currently supports the service options 2, 9, (loopback service options) and 1, 3, 17, 0x8000 (speech service options).

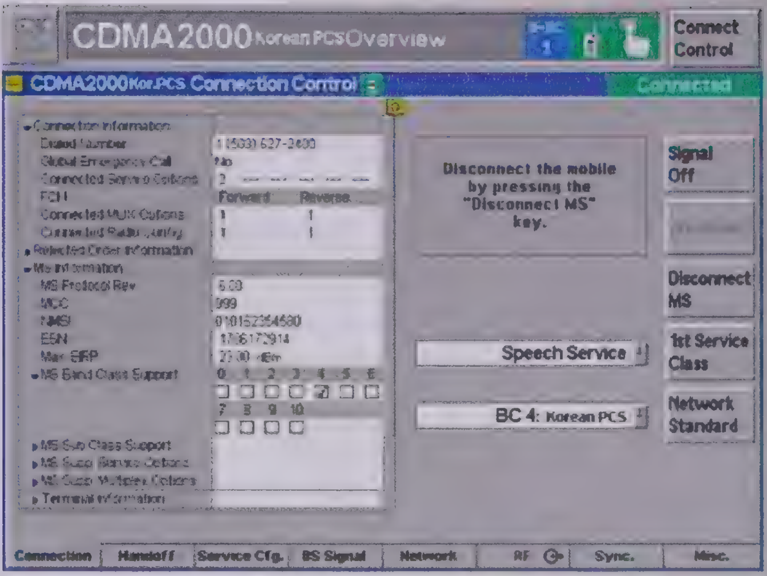
All relevant base station parameters and connection settings can be configured in user-friendly menus.

As with all mobile radio networks supported by the CMU200, two different measurement modes are basically available:

On the one hand, there are tests in the non-signalling mode, which permit an analysis of the mobile without registration in the base station and without actual call setup. For this purpose, the CMU generates a base station signal with all the physical channels required, which are user-configurable. This measurement mode complies in particular with the demands for high measurement speed in production lines.

On the other hand, there are tests with complete signalling.

The connection menu is the central point for setting up the connection. You can choose between voice loopback and test loopback mode.

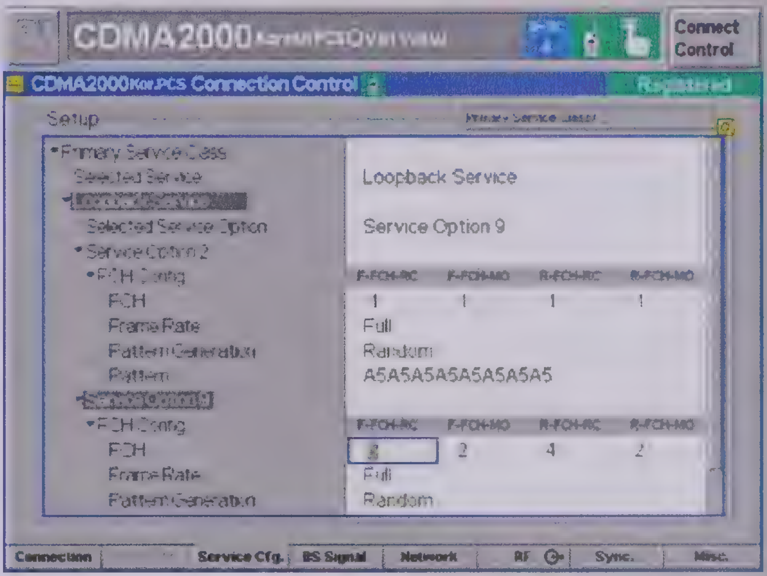

CDMA2000 Korean PCS Overview
Connect Control
CDMA2000 Kor.PCS Connection Control
Connected
Connection Information
Forward
Reverse
MS Protocol Rev
ESN
Max EIRP
MS Band Class Support
Signal Off
Disconnect MS
1st Service Class
Network Standard
Connection
Handoff
Service Cfg.
BS Signal
Network
RF
Sync.
Misc.

Disconnect the mobile by pressing the "Disconnect MS" key.

Speech Service

BC 4: Korean PCS

The service config menu allows the basic channel to be configured for the different service options. Choose RC1/RC2 for TIA/EIA-95 based connections, or RC3, RC4, RC5 for real CDMA2000 calls.


CDMA2000
Connect Control
CDMA2000 Kor.PCS Connection Control
Registered
Setup
Primary Service Class
F-FCH-RC
F-FCH-MO
R-FCH-RC
R-FCH-MO
Connection
Service Cfg.
BS Signal
Network
RF
Sync.
Misc.

Loopback Service

Service Option 9

FCH 1 1 1 1

Frame Rate Full

Pattern Generation Random

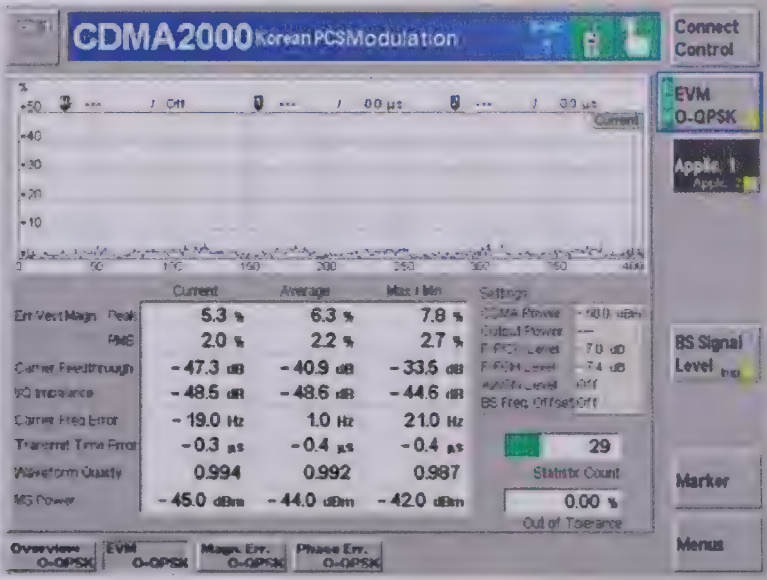
Pattern A5A5A5A5A5A5A5A5

FCH 3 2 4 2

Frame Rate Full

Pattern Generation Random

With the modulation measurements you can check the MS transmitter. Parameters like EVM, phase error and frequency error are displayed in graphically.


CDMA2000 Korean PCS Modulation
Connect Control
%
+50
+40
+30
+20
+10
0
50
100
150
200
250
300
350
400
Current
EVM O-QPSK
Applic. 1
BS Signal Level
Marker
Menus
Settings
Statistic Count
Out of Tolerance
Overview O-QPSK
EVM O-QPSK
Magn. Err. O-QPSK
Phase Err. O-QPSK

		Current	Average	Max / Min
Err Vect Magn	Peak	5.3 %	6.3 %	7.8 %
	RMS	2.0 %	2.2 %	2.7 %
Carrier Feedthrough		-47.3 dB	-40.9 dB	-33.5 dB
I/Q Imbalance		-48.5 dB	-48.6 dB	-44.6 dB
Carrier Freq Error		-19.0 Hz	1.0 Hz	21.0 Hz
Transmit Time Error		-0.3 µs	-0.4 µs	-0.4 µs
Waveform Quality		0.994	0.992	0.987
MS Power		-45.0 dBm	-44.0 dBm	-42.0 dBm

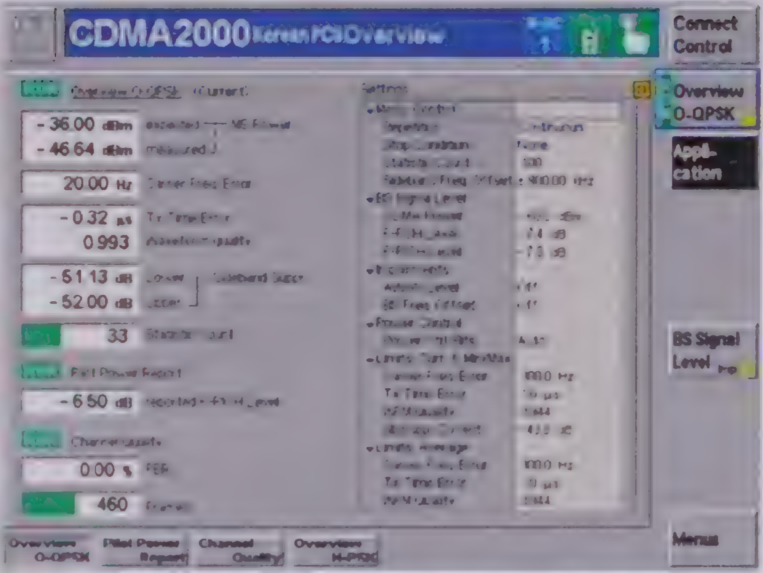
Statistic Count 29

Out of Tolerance 0.00 %

[illegible]

The following describes the range of functions in detail:

- Power measurements
  - Minimum/maximum output power
  - Gated output power
- Receiver quality measurements
  - Frame error rate (FER)
  - Dynamic range, sensitivity and other user-selectable test environments
- Modulation (both RC1/2 and RC3/4)
  - Error vector magnitude (EVM), magnitude error, phase error, waveform quality, carrier feedthrough, frequency error
- Code domain power
  - Code domain power
  - Peak code domain error power, channel power
- Handoffs
  - Implicit handoffs (RF channel, Walsh code, PN offset, frame offset)
  - Interband handoff
  - Handoff to AMPS
- Sideband suppression



The overview menu displays all relevant TX parameters such as power, frequency error, waveform quality (both for RC1/2 and RC3/4) as well as sideband suppression, reported pilot power and frame error rate (FER)

Non-signalling mode

- High-speed power measurement
- Frequency error
- Waveform quality (both RC1/2 and RC3/4)
- Carrier feedthrough
- Transmit time error
- Sideband suppression

CDMA2000 specifications – Mobile station test

Standards	
CDMA2000 standards	TIA/EIA IS 2000 Rev 0
[illegible]	TIA/EIA IS 98 D

[illegible]

Frequency range	
Option CMU-K83	
NMT 450 (band class 5)	421.675 MHz to 494.480 MHz
Option CMU-K84	
US/Korean cellular (band class 0)	869.025 MHz to 893.985 MHz
TACS band (band class 2)	917.0125 MHz to 959.9875 MHz
JTACS band (band class 3)	832.0125 MHz to 869.9875 MHz
[illegible] band (band class 7)	746.000 MHz to 764.000 MHz
900 MHz band (band class 9)	[illegible]
Secondary 800 MHz band (band class 10)	851.000 MHz to 939.975 MHz
Option CMU-K85:	
North American PCS (band class 1)	1930 MHz to 1990 MHz
Korean PCS (band class 4)	1840 MHz to 1870 MHz
1800 MHz band (band class 8)	1805.000 MHz to 1879.950 MHz
Option CMU-K86	
IMT-2000 (band class 6)	2110.000 MHz to 2169.950 MHz
Frequency resolution	channel spacing according to standard
Frequency uncertainty	same as time base

Output level range (modulated signal)	
RF1	–120 dBm to –33 dBm
RF2	–120 dBm to –16 dBm
RF3OUT	–80 dBm to +7 dBm
Output level resolution (modulated signal)	0.1 dB

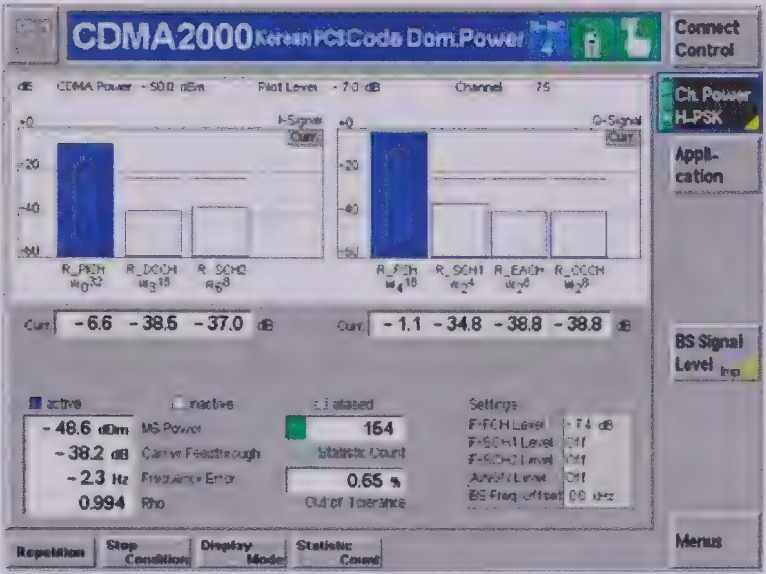
Output level uncertainty

	+23°C to +35°C	+5°C to +45°C
RF1, RF2 ≥–108 dBm	<0.5 dB	<0.7 dB
RF3OUT –80 dBm to +4 dBm	<0.7 dB	<0.9 dB

Modulation	
Dual BPSK, multiple QPSK	1.2288 Mcps
AWGN	see AWGN generator
Carrier suppression	>35 dB
Waveform quality factor (ρ)	>0.985
Code channel level uncertainty (relative to total CDMA power)	
F-PICH, F-PCH, F-FCH, F-SCH1, F-SCH2	0.1 dB typ.
All other channels	[illegible] dB typ.
Code channel resolution	0.1 dB
AWGN generator	
Bandwidth	>1.8 MHz
Output level resolution	0.1 dB
Output level uncertainty	0.2 dB typ. (1.23 MHz bandwidth)
Output level range (relative to total CDMA output power)	–20 dB to +4 dB
Supported service options	
Loopback service options	SO 2, 9
Speech service options	SO 1, 3, 17, 0x8000

CDMA2000 Highlights of CMU200

- Voice loopback and comprehensive testing of mobiles
- Full support of RC1/RC2 (cdmaOne measurements)
- Support of all band classes specified in IS-2000
- Innovative measurement of code domain power, code domain peak error power, channel power
- Parallel RX/TX measurements ensure high throughput in production environments
- Graphical representation of measurement results best suited for R&D labs
- Readout and display of many mobile specific parameters (ESN, slot cycle index, etc.)
- Extremely fast measurements
- Non-signalling and signalling mode
- Various handoffs supported (e.g. handoff to AMPS, interband handoff)



CDMA Power -50.0 dBm Pilot Level -7.0 dB Channel 75

Curr -6.6 -38.5 -37.0 dB

Curr -1.1 -34.8 -38.8 -38.8 dB

-48.6 dBm MS Power
-38.2 dB Carrier Feedthrough
-2.3 Hz Frequency Error
0.994 Rho

164 Statistic Count
0.65 % Out of Tolerance

Settings
F-FCH Level -7.4 dB
F-SCH1 Level Off
F-SCH2 Level Off
Level Off
BS Freq. offset 0.0 kHz

The channel power measurement displays the power in the channels used by the reverse link, separated into I and Q signal

RF analyzer

Frequency range	
Option CMU-K83:	
NMT-450 (band class 5)	411.675 MHz to 483.480 MHz
Option CMU-K84:	
US/Korean cellular (band class 0)	824.025 MHz to 848.985 MHz
TACS band (band class 2)	872.0125 MHz to 914.9875 MHz
JTACS band (band class 3)	887.0125 MHz to 924.9875 MHz
North American 700 MHz cellular band (band class 7)	776.000 MHz to 794.000 MHz
900 MHz band (band class 9)	880.000 MHz to 913.750 MHz
Secondary 800 MHz band (band class 10)	806.000 MHz to 900.975 MHz
Option CMU-K85:	
North American PCS (band class 1)	1850 MHz to 1910 MHz
Korean PCS (band class 4)	1750 MHz to 1780 MHz
1800 MHz band (band class 8)	1710.000 MHz to 1784.950 MHz
Option CMU-K86:	
IMT-2000 (band class 6)	1920.000 MHz to 1979.950 MHz
Measurement filter	according to standard (1.23 MHz bandwidth)
Frequency resolution	channel spacing according to standard
Level range (HPSK, O-QPSK signal)	
RF1	–40 dBm to +44 dBm
RF2	–54 dBm to +30 dBm
RF4IN	–80 dBm to –9 dBm

Power meter (frequency-selective)

Level uncertainty		
	+23°C to +35°C	+5°C to +45°C
RF1, RF2, RF4IN	<0.5 dB	<0.7 dB
Level resolution	0.1 dB	

Modulation analyzer

RC1, RC2 (O-QPSK):
Waveform quality, error vector magnitude, magnitude error, phase error

ρ uncertainty (for ρ 0.9 to 1)	<0.003
Frequency measurement range	–3 kHz to +3 kHz
Frequency measurement uncertainty	<30 Hz + drift of time base

RC3, RC4 (HPSK):
Waveform quality, error vector magnitude, magnitude error, phase error, code domain power, peak code domain error power, channel power

ρ uncertainty (for ρ 0.9 to 1)	<0.003
Frequency measurement range	–3 kHz to +3 kHz
Frequency measurement uncertainty	<10 Hz + drift of time base
Relative measurement uncertainty result > –33 dB	<0.1 dB

WCDMA in CMU 200

The need for higher data rates is the trend in our information-oriented society in the new millennium. The enhancement of mobile phones takes this need into account on the way to the next generation of wireless communication. How to cover these future challenges? Driven by ideas of the first and second generation (SIM, global roaming, military CDMA technology, data services), WCDMA will take all of these fundamentals to unprecedented levels and add new applications and higher data security. Derived from Asian, American and European ideas, 3G is getting ready to be the mobile solution for future needs as well as the current applications.

WCDMA

Depending on the level of mobility, WCDMA provides several times the capacity of 2nd generation CDMA or TDMA systems.

Thanks to the modular concept of the CMU 200, WCDMA functionality plus e.g. GSM, TDMA (TIA/EIA-136), AMPS and other wireless standards such as *Bluetooth* wireless technology, can be implemented in a single unit at the same time.

WCDMA FDD functionality

The tests are based on the 3GPP/FDD, release 99 WCDMA radio link standards, version June 2001. The CMU 200 can easily be upgraded to different functionality steps by means of hardware and software options for non-signalling TX/RX measurements and signalling measurements. All measurements comply with the 3GPP specification TS 34.121. This is especially interesting due to the variety of different filter bandwidths and shapes for ACLR, SEM, MIN power, MAX power, etc that are to be used according to the specification. Due to the highly user-friendly menu concept, the CMU 200 provides quick access to all measurements desired and optimizes handling and consequently efficiency.

Non-signalling mode

The non-signalling mode is for generating and analyzing WCDMA (3GPP/FDD) signals in the frequency range of the CMU 200 base unit. The CMU 200 provides WCDMA-specific TX measurements on signals with up to 6 DPDCHs such as

- ACLR (adjacent channel leakage power ratio): two measurement modes, filter (bargraph) and FFT (cont. spectrum) method, absolute or relative readout
- OBW (occupied bandwidth)
- SEM (spectrum emission mask)
- CDP (code domain power): CDP vs all codes, CDP vs DCH channels, RHO versus all codes, RHO versus DCH channels. All measurements in relative or absolute readout
- Modulation (for 3GPP or general QPSK): EVM (error vector magnitude), magnitude error, phase error, frequency error, I/Q offset, I/Q imbalance, peak code domain error, RHO (waveform quality)
- Power: MAX, MIN, OFF (UE test mode)
- Autoranging for received UE signal

The non-signalling mode allows tests of all essential RF parameters of the connected UE (user equipment). The measurements are performed in unsynchronized mode. No time-consuming call setup is done to evaluate UE performance using these measurements.

RX measurements

A synchronization (but still no call setup) is needed for RX evaluation, synchronized TX measurements and some additional TX measurements, such as

- Inner loop power control with TPC commands: TPC stepping measurement (UE receives TPC commands from CMU 200 generator)
- Receiver quality: BER, BLER, (with UE-assisted evaluation, no RF loopback)

The generated channels and functions available are

- P-CPICH/P-SCH/S-SCH/P-CCPCH/DPCCH/DPDCH
- TPC profiles

In conjunction with the Rohde & Schwarz Baseband Fading Simulator ABFS and the planned option CMU-B17, conditions of fading may be simulated and evaluated with the CMU 200.

FDD signalling mode (planned)

Signalling tests are tests carried out in an environment closer to a real-life network. However, in a production context they may not be absolutely neccessary.

In this mode the CMU 200 simulates a WCDMA base-station RF interface including the signalling protocol so that a mobile can be tested with regard to different signalling parameters. All necessary network and Node B (base station) parameters such as control and data channel configurations can be set. This mode will be supported in a next step. In addition to the non-signalling tests, it provides features such as

- Power: MAX, MIN, OFF (UE signalling mode)
- Power control: ON/OFF time mask, open loop power control, inner loop power control (3GPP mode)
- Receiver quality: BER, BLER, (with RF loopback)
- Call setup and release / paging
- Test mode connection

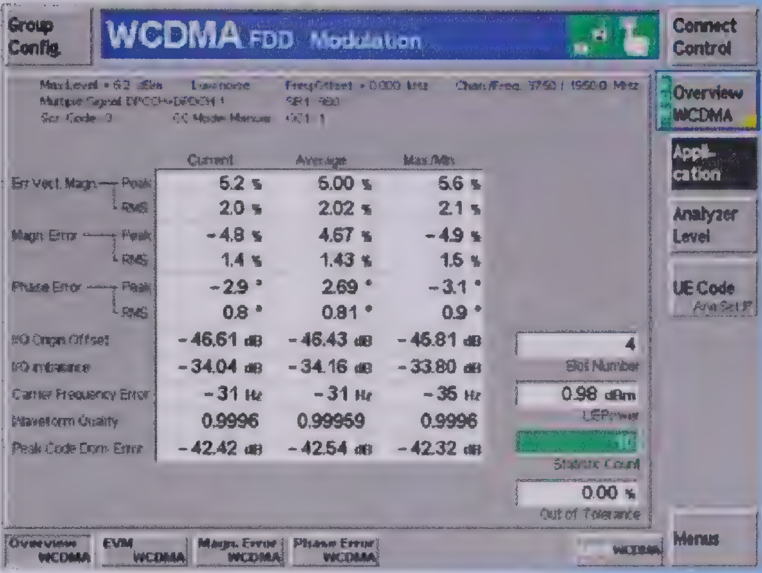
WCDMA development

With its great versatility the CMU 200 is also a suitable tool for the development of mobile phones. Four configurable RF connectors are provided to enable flexible signal levels. The clearly structured and user-friendly menu design together with the clear-cut screen layout provides quick access to all features and ensures trouble-free monitoring of the device under test. The tester can be switched between 3GPP and general QPSK modes to increase the usability with DUTs under development.

Quality assurance

Due to its high measurement repeatability and accuracy, the CMU 200 is the right choice to ensure a consistently high quality standard. WCDMA-specific measurements such as BER, EVM, and full implementation of complementary (i.e. ACLR and OBW) measurements provide an excellent test platform to guarantee the production of high-quality devices.

The overview menu provides fast comprehensive information on the UE's RF performance. The hotkeys at the bottom of the screen give immediate access to specific and detailed measurements.

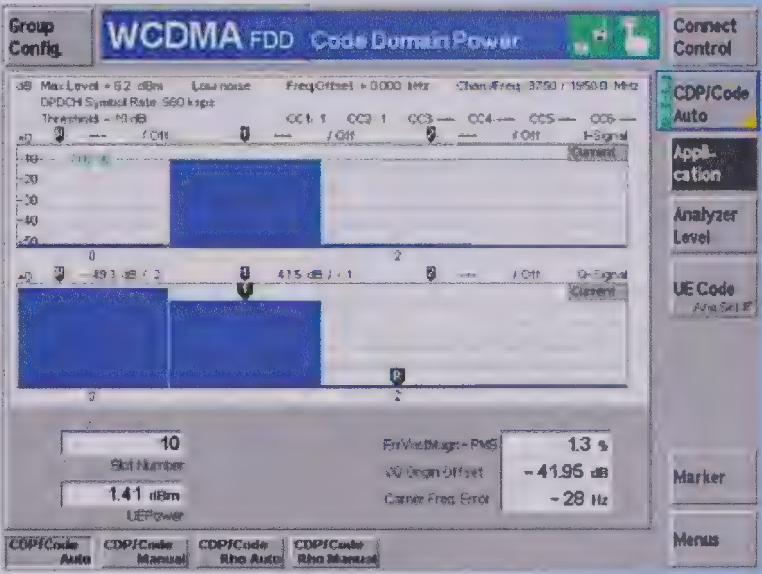


Group Config
WCDMA FDD Modulation
Connect Control
Overview WCDMA
Appli-cation
Analyzer Level
UE Code
Menus
Overview WCDMA
EVM WCDMA
Magn. Error WCDMA
Phase Error WCDMA

		Current	Average	Max/Min
Err Vect. Magn.	Peak	5.2 %	5.00 %	5.6 %
	RMS	2.0 %	2.02 %	2.1 %
Magn. Error	Peak	-4.8 %	4.67 %	-4.9 %
	RMS	1.4 %	1.43 %	1.5 %
Phase Error	Peak	-2.9 °	2.69 °	-3.1 °
	RMS	0.8 °	0.81 °	0.9 °
I/Q Origin Offset		-46.61 dB	-46.43 dB	-46.81 dB
I/Q Imbalance		-34.04 dB	-34.16 dB	-33.80 dB
Carrier Frequency Error		-31 Hz	-31 Hz	-35 Hz
Waveform Quality		0.9996	0.99959	0.9996
Peak Code Dom. Error		-42.42 dB	-42.54 dB	-42.32 dB

Slot Number: 4
UE Power: 0.98 dBm
Statistic Count: 10
Out of Tolerance: 0.00 %

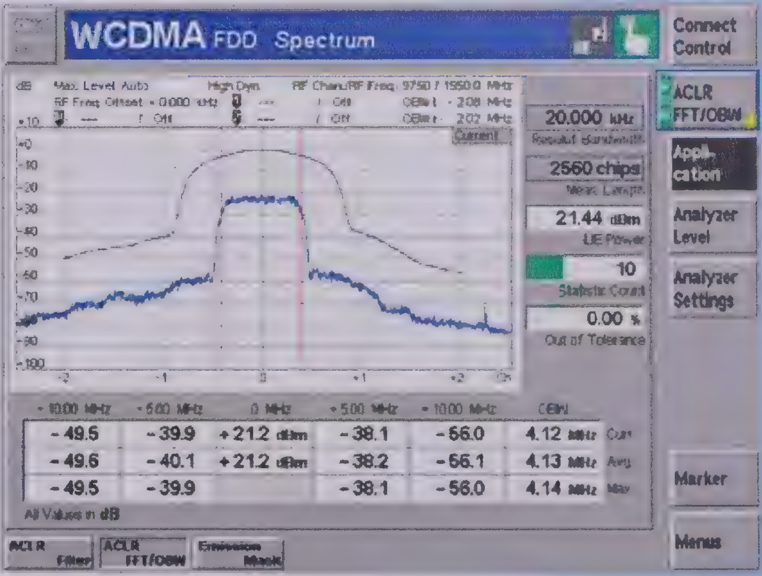
The screenshot shown here is just one of the 4 comprehensive ways to display the UE code domain power in non-signalling mode.



Group Config
WCDMA FDD Code Domain Power
Connect Control
CDP/Code Auto
Appli-cation
Analyzer Level
UE Code
Marker
Menus
CDP/Code Auto
CDP/Code Manual
CDP/Code Rho Auto
CDP/Code Rho Manual

Slot Number: 10
UE Power: 1.41 dBm
Err Vect Magn - RMS: 1.3 %
I/Q Origin Offset: -41.95 dB
Carrier Freq Error: -28 Hz

The ACLR menu shows all adjacent-channel-related information in graphical as well as in scalar numerical form. Since the ACLR FFT and OBW measurement methods are closely related, results for occupied bandwidth are displayed simultaneously. The scalar display excluding the center channel (0 MHz) may be switched to absolute readout as well.



WCDMA FDD Spectrum
Connect Control
ACLR FFT/OBW
Appli-cation
Analyzer Level
Analyzer Settings
Marker
Menus
ACLR Filter
ACLR FFT/OBW
Emission Mask

Result Bandwidth: 20.000 kHz
Meas. Length: 2560 chips
UE Power: 21.44 dBm
Statistic Count: 10
Out of Tolerance: 0.00 %

-10.00 MHz	-5.00 MHz	0 MHz	+5.00 MHz	+10.00 MHz	OBW	
-49.5	-39.9	+21.2 dBm	-38.1	-56.0	4.12 MHz	Curr
-49.6	-40.1	+21.2 dBm	-38.2	-56.1	4.13 MHz	Avg
-49.5	-39.9		-38.1	-56.0	4.14 MHz	Max

All Values in dB

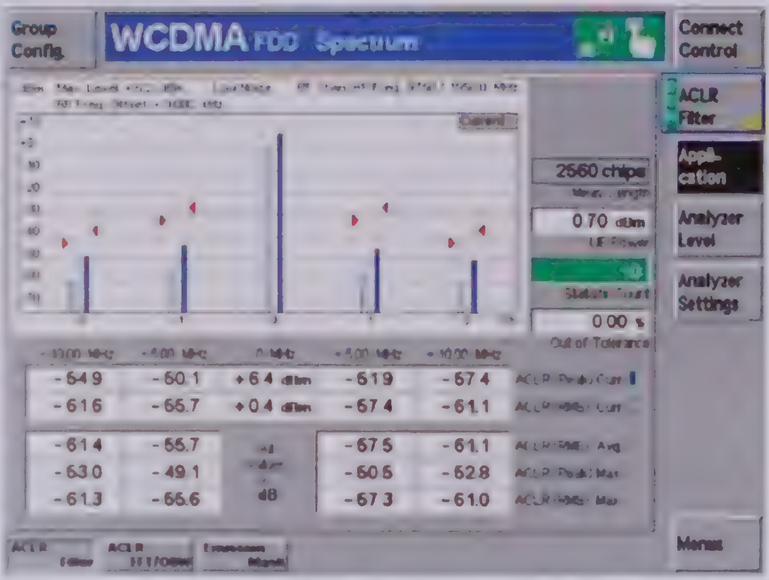
WCDMA in CMU 200

Production of mobile phones

The production of mobile phones requires time-efficient and cost-effective means that ensure both high throughput and state-of-the-art accuracy. Thanks to the unique IEC/IEEE-bus concept of the CMU 200, these two goals can be easily achieved in your production line. The intelligent handling of the GPIB commands received thoroughly optimizes the speed for WCDMA-specific measurements. In practice, this will mean reduced test time and enhanced test yield.

Switching standards

The flexibility of the CMU 200 makes for quick and simple switching between different standards. This is very important as many 3GPP UEs for markets with networks of these second generation standards are going to be dual-mode even without a handover being defined. Switching between WCDMA and any other CMU 200 supported standard can



2560 chips
Meas. Length
0.70 dBm
UE Power
0.00 %
Out of Tolerance

-10.00 MHz	-5.00 MHz	0 MHz	+5.00 MHz	+10.00 MHz	
-64.9	-60.1	+6.4 dBm	-61.9	-67.4	ACLR Peak Curr
-61.6	-65.7	+0.4 dBm	-67.4	-61.1	ACLR RMS Curr
-61.4	-55.7	dB	-67.5	-61.1	ACLR RMS Avg
-63.0	-49.1		-60.5	-62.8	ACLR Peak Max
-61.3	-65.6		-67.3	-61.0	ACLR RMS Max

ACLR measurements are available using two different measurement methods and displays. In this screenshot, the ACLR is measured using the filter method to obtain results for 5 channels. The scalar display excluding the center channel (0 MHz) may be switched to absolute readout as well.

WCDMA specifications

Mobile station (UE) test

Standard	3GPP FDD
Symbol rate	3.84 MHz
Synchronization output 2	BNC connector REFOUT2
Frequency	30.72 MHz

[illegible]	P-CPICH, P-SCH, S-SCH, P-CCPCH, DPCH
[illegible]	–30 dB to +15 dB relative to CPICH
Reference measurement channel RMC	12.2 kbps, 64 kbps, 144 kbps, 384 kbps (3GPP TS34.121)
Frequency range	869 MHz to 894 MHz 921 MHz to 960 MHz 1805 MHz to 1880 MHz 1930 MHz to 1990 MHz 2110 MHz to 2170 MHz
Frequency resolution	0.1 Hz
Output level range[1]	
RF1	–120 dBm to –36 dBm
RF2	–120 dBm to –22 dBm
RF3OUT	–80 dBm to 0 dBm

Output level uncertainty

	[illegible]	+5°C to +45°C
RF1, RF2 ≥–110 dBm	[illegible]	<0.9 dB
RF3OUT ≥–80 dBm	[illegible]	<1.0 dB

Signal quality	
Error vector magnitude (EVM)	<5%[2]

RF analyzer (TX measurements)

Frequency range	824 MHz to 849 MHz 876 MHz to 915 MHz 1710 MHz to 1785 MHz 1850 MHz to 1910 MHz 1920 MHz to 1980 MHz
Frequency resolution	1 Hz
Reference level for full dynamic range	
RF1	
Continuous power[3]	0 dBm to +47 dBm
Peak envelope power (PEP)[4]	0 dBm to +53 dBm
RF2	
Continuous power	–14 dBm to +33 dBm
Peak envelope power (PEP)[4]	–14 dBm to +39 dBm
RF4IN	
Continuous power and PEP	–37 dBm to +0 dBm

Modulation analysis [5]

Measurement filter	receiver filter according to standard 3.84 MHz, RRC, a=0.22
Analysis modes	QPSK, WCDMA uplink
Error vector magnitude (EVM)	
Measurement range	up to 25 %
Inherent EVM, rms	<2.5 %[6]
Resolution	0.1 %
Frequency error	
Measurement range[7]	±3 kHz
Uncertainty	<10 Hz + drift of time base
Resolution	1 Hz
I/Q offset	
Inherent I/Q offset	<–55 dB
Resolution	0.01 dB
I/Q imbalance	
Inherent I/Q imbalance	<–30 dB
Resolution	0.01 dB
Waveform quality	
Measurement range	0.9 to 1.0
Uncertainty	<0.002
Resolution	0.0001

---

[1] *For crest factor ≤13 dB*

[2] *Global EVM for DL reference measurement channels (according 3GPP TS34.121 C3.1 to C3.4) with DPCH/CPICH = 0 dB*

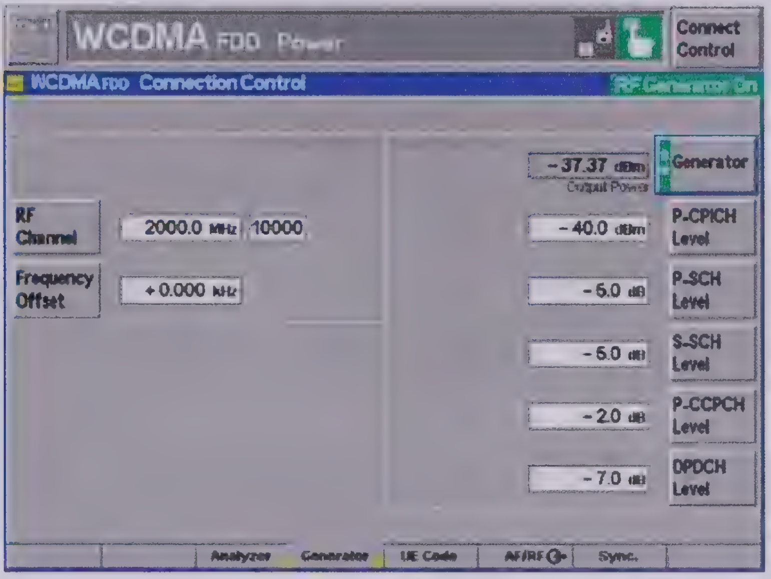
[3] *50 W in temperature range +5 °C to +30 °C, linear degradation down to 25 W at 45 °C.*

[4] *Mean value of power vs time must be equal to or less than allowed continuous power.*

[5] *The specified data is valid for "Low Noise Mode" operation.*

[6] *With CMU-Z6 <1.5 % typ.*

[7] *At 12.2 kbps reference measurement channel.*



RF Channel: 2000.0 MHz 10000

Frequency Offset: +0.000 kHz

Output Power: −37.37 dBm

P-CPICH Level: −40.0 dBm

P-SCH Level: −5.0 dB

S-SCH Level: −5.0 dB

P-CCPCH Level: −2.0 dB

DPDCH Level: −7.0 dB

This screenshot shows the independent generator settings for the various channels. All channels can be set relative to the pilot in a wide level range.

be achieved by a simple remote command or by pressing a button. It allows a very versatile production test layout and improves the flexibility and throughput of your multimode UE application.

WCDMA highlights of CMU200

WCDMA-related features

- Shortest measurement time ensuring high throughput
- Benchmark-breaking IEEE-bus speed (see highlights of base unit)
- Combined measurements, many different measurement modes
- Multiband/multimode testing
- Powerful signalling capabilities as part of a clear upgrade path
- Mobile- or base-station originated call connect/disconnect available as a next functionality step
- Simple interactive operation, standardized MMI
- No specialized network knowledge required

Peak code domain error (PCDE)	
Uncertainty	<0.5 dB
Resolution	0.01 dB

Spectrum measurements [8]

ACLR(FFT)	
Measurement filter	receiver filter according to standard 3.84 MHz, RRC, a=0.22
Resolution bandwidth	20 kHz
Frequency offsets	
First adjacent channel	±5 MHz
Second adjacent channel	±10 MHz
Dynamic range	
First adjacent channel	>54 dB
Second adjacent channel	>62 dB
Resolution	0.1 dB
ACLR (filter)	
Measurement filter	receiver filter according to standard 3.84 MHz, RRC, a=0.22
Frequency offsets	
First adjacent channel	±5 MHz
Second adjacent channel	±10 MHz
Dynamic range	
First adjacent channel	>54 dB
Second adjacent channel	>62 dB
Resolution	0.1 dB
Occupied bandwidth	
Range	1 MHz to 6 MHz
Uncertainty	<100 kHz
Resolution	20 kHz
Spectrum emission mask	
Measurement filter	
± 2.515 MHz to ± 3.485 MHz	30 kHz Gaussian filter
± 4.0 MHz to ± 12.0 MHz	1 MHz Gaussian filter
Dynamic range	
± 2.515 MHz to ± 3.485 MHz	>72 dB
± 4.0 MHz to ± 7.5 MHz	>59 dB
± 8.5 MHz to ± 12.0 MHz	>67 dB

Resolution	0.1 dB

Power measurements [5]

Maximum power	wideband filter
Minimum/off power	receiver filter acc. to standard 3.84 MHz, RRC, a=0.22

Level range

	RF1	RF2	RF4IN
Continuous power	–52 dBm to +47 dBm[3]	–66 dBm to +33 dBm	–89 dBm to 0 dBm[10]
Peak envelope power (PEP)	–42 dBm to +53 dBm[4]	–56 dBm to +39 dBm[4]	–79 dBm to 0 dBm

Level uncertainty

	+23°C to +35°C	+5°C to +45°C
RF1		
–10 dBm to +47 dBm, rms	<0.5 dB	<0.7dB
–44 dBm to –10 dBm, rms	<0.7 dB	<0.9 dB
RF2		
–24 dBm to +33 dBm, rms	<0.5 dB	<0.7 dB
–60 dBm to –24 dBm, rms	<0.7 dB	<0.9 dB
RF4IN		
–24 dBm to 0 dBm, rms	<0.5 dB	<0.7 dB
–85 dBm to –24 dBm, rms	<0.7 dB	<0.9 dB
Level resolution	0.01 dB	

Code domain power

Measurement filter	receiver filter according to standard 3.84 MHz, RRC, a=0.22
Level range	
RF1	–8 dBm to +47 dBm
RF2	–22 dBm to +33 dBm
RF4IN	–45 dBm to 0 dBm
Level resolution	0.01 dB

---

[9] *The specified data is valid for "High Dynamic Mode" operation.*

[10] *Upper limit depends on crest factor.*

Bluetooth™ measurements in CMU 200

General

The CMU 200 was the first *Bluetooth* test set on the market and is the only tester which performs all measurements in full hopping, reduced hopping or non-hopping mode. Measurements using DH1, DH3 and DH5 packets are supported. According to the *Bluetooth* Test Mode Specification, the DUT has to be locally enabled for test mode operation. The CMU 200 switches the DUT to test mode and performs a number of basic RF measurements (TX and RX).

Applications

The CMU 200 with the *Bluetooth* option is the ideal instrument for production, development and maintenance of any kind of devices with integrated *Bluetooth* interface.

Due to its modular platform concept, the CMU 200 is the ideal solution for all cellular standard mobile phones production lines.

Parallel operation for high measurement speed

Due to the high measurement speed and large memory capacity of the CMU 200, transmitter and receiver measurements can be carried out simultaneously. When measurements are performed in frequency hopping mode, a great test depth is rapidly attained. Only a few seconds are required between call setup, transmitter and receiver measurements and call detach. Fast test cycles guarantee a fast return of investment.

Many convenient measurement functions

The CMU 200 offers a great number of statistical monitoring and measurement functions. It is possible, for instance, to define individual tolerances for each measured value and to stop a measurement sequence after a certain number of measurements or when a tolerance has been exceeded. Besides the common traces for power and modulation versus time, averaged minimum or maximum traces can also be displayed over a user-defined number of packets.

Signalling

Setting up a *Bluetooth* connection

The CMU 200 acts as the master of a *Bluetooth* piconet, the DUT as a slave. The CMU 200 is able to perform the inquiry procedure for the identification of all *Bluetooth* devices within range of the CMU 200. All devices found are listed on the display and one of them can be selected for the paging procedure. The CMU 200 then establishes the connection to the DUT and switches it to test mode operation.

The inquiry procedure can be skipped, if the *Bluetooth* device address of the DUT is already known. In this case a shorter setup time for the connection can be achieved. This is important for production tests of *Bluetooth* devices to increase the maximum throughput of a production line.

Signalling information from the DUT

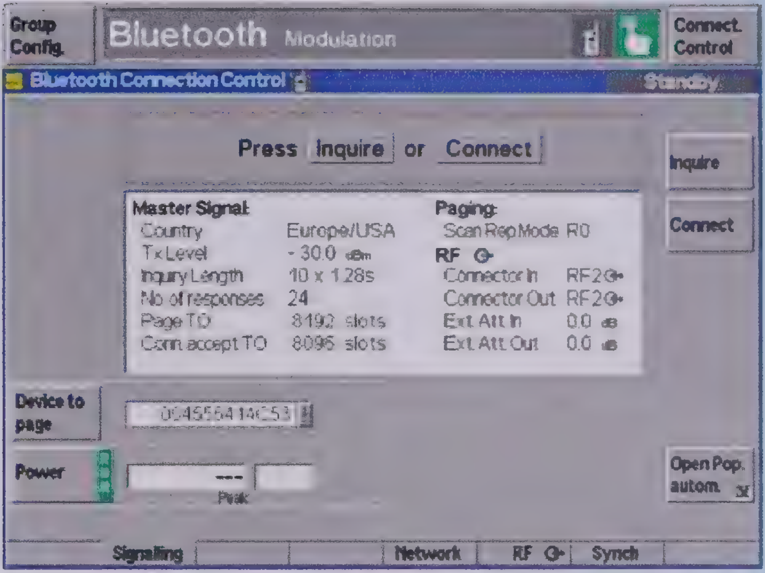
The CMU 200 is able to display a variety of information which is received from the DUT (e.g. device name, version numbers, service class, supported features).

Compliance with existing Bluetooth standards

The CMU 200 is compliant with the *Bluetooth* Core Specifications Ver. 1.0 B and 1.1. The *Bluetooth* Test Mode (Core Spec. Part I:1) is implemented with all commands needed to perform the TX/RX measurements.

The *Bluetooth* RF Test Specification Ver. 0.91 describes RF test cases for the *Bluetooth* qualification process. Rohde & Schwarz offers the Test System TS8960 for *Bluetooth* qualification tests, which is fully compliant with the RF Test Specification. Although the CMU 200 was not designed for qualification tests, the RF Test Specification was taken as a guideline for the implementation of the CMU 200's *Bluetooth* measurements. All TX measurements are implemented according to the test specification 0.91.

The connection control menu allows the addresses of all Bluetooth devices in range to be inquired. The "Device to page" softkey then selects the DUT for the measurements. Alternatively, the input of a known address is possible.


Group Config.
Bluetooth Modulation
Connect. Control
Bluetooth Connection Control
Standby
Inquire
Connect
Device to page
Power
Peak
Open Pop. autom.
Signalling
Network
RF
Synch

Press Inquire or Connect

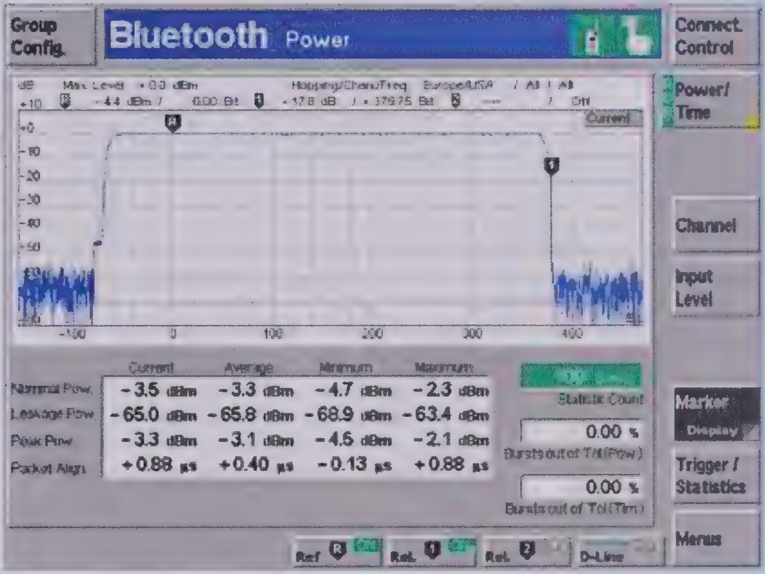
Master Signal:
Country Europe/USA
Tx Level - 30.0 dBm
Inquiry Length 10 x 1.28s
No of responses 24
Page TO 8192 slots
Conn accept TO 8096 slots

Paging:
Scan Rep Mode R0

RF
Connector In RF2
Connector Out RF2
Ext Att In 0.0 dB
Ext Att Out 0.0 dB

Device to page: 0045554 14C53

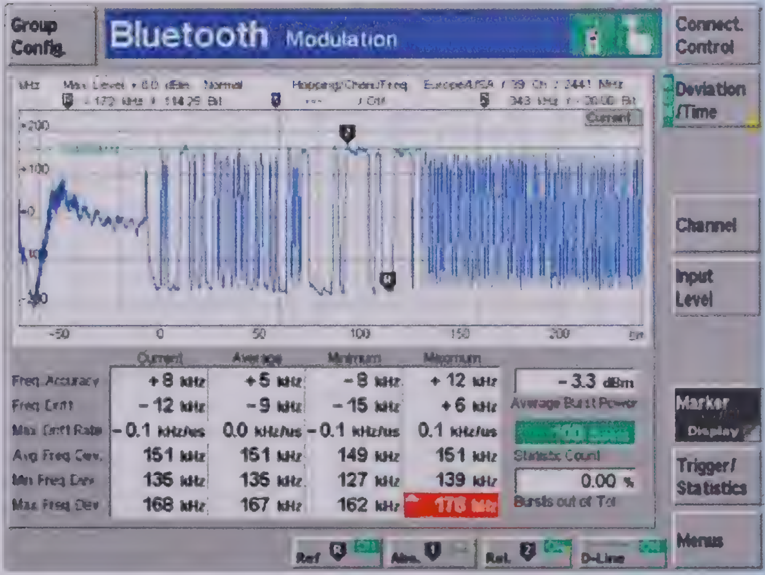
The power menu shows the results in graphical and scalar form. Statistical functions as well as convenient markers facilitate further evaluation. The timing measurement complements the numerical power results.


Group Config.
Bluetooth Power
Connect. Control
Power/ Time
Channel
Input Level
Marker Display
Trigger / Statistics
Menus
Current
-100
0
100
200
300
400
Ref
Rel.
Rel.
D-Line

	Current	Average	Minimum	Maximum
Nominal Pow.	-3.5 dBm	-3.3 dBm	-4.7 dBm	-2.3 dBm
Leakage Pow.	-65.0 dBm	-65.8 dBm	-68.9 dBm	-63.4 dBm
Peak Pow.	-3.3 dBm	-3.1 dBm	-4.6 dBm	-2.1 dBm
Packet Align.	+0.88 µs	+0.40 µs	-0.13 µs	+0.88 µs

Statistic Count
0.00 % Bursts out of Tol (Pow.)
0.00 % Bursts out of Tol (Tim.)

The graphical display of the modulation results may be spread between 1/1 and 1/16 of a burst for in-depth analysis. The "Max. Freq. Dev." and "Min. Freq. Dev." results allow the highest and lowest values for 10 bit long fractions of a payload to be evaluated individually.


Group Config.
Bluetooth Modulation
Connect. Control
Deviation /Time
Channel
Input Level
Marker Display
Trigger/ Statistics
Menus
Current
+200
+100
+0
-200
-50
0
50
100
150
200
Bit
Ref
Abs.
Rel.
D-Line

	Current	Average	Minimum	Maximum
Freq. Accuracy	+8 kHz	+5 kHz	-8 kHz	+12 kHz
Freq. Drift	-12 kHz	-9 kHz	-15 kHz	+6 kHz
Max. Drift Rate	-0.1 kHz/us	0.0 kHz/us	-0.1 kHz/us	0.1 kHz/us
Avg. Freq. Dev.	151 kHz	151 kHz	149 kHz	151 kHz
Min. Freq. Dev.	135 kHz	135 kHz	127 kHz	139 kHz
Max. Freq. Dev.	168 kHz	167 kHz	162 kHz	176 kHz

-3.3 dBm Average Burst Power
100 Statistic Count
0.00 % Bursts out of Tol

Bluetooth wireless technology in CMU200

TX measurements

The current measurement values for each parameter are displayed on the CMU200 screen. Additionally, average, maximum and minimum values are displayed as a result of a statistical evaluation of a settable number of *Bluetooth* packets (bursts).

Power measurements (output power)

Measurement parameters:

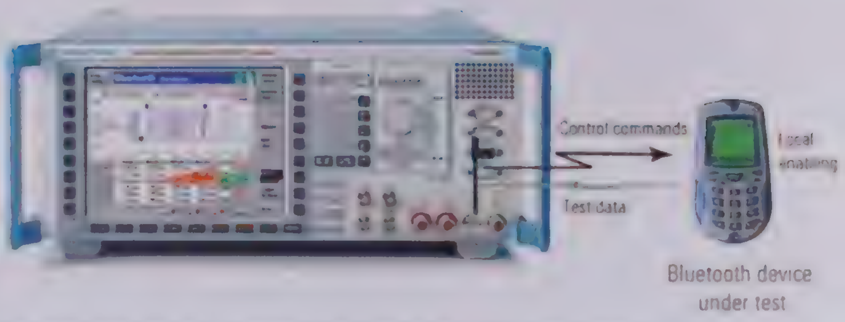
- Nominal power (measured as the part of the burst starting at the detected 1st bit of the preamble (bit 0) to the last bit of the burst)
- Peak power (shows the highest power level within a burst)
- Leakage power (measured within defined areas before and after the burst)

Timing measurements (packet timing error)

Measurement parameter:

- Packet alignment (distance between ideal master receiver slot and detected bit 0 of the received burst)

This measurement is displayed on the "Power" screen.



The device under test can be connected to the CMU200 via an RF coupler (antenna) or a cable

Modulation measurements (modulation characteristics/quality)

Measurement parameters:

- Frequency accuracy/Initial carrier frequency tolerance ICFT (difference between measured frequency and intended transmitted frequency, measured in the preamble at the beginning of a packet)
- Carrier frequency drift (difference between the frequency at the start of the packet and the frequency in the payload)
- Maximum drift rate (maximum drift rate anywhere within the packet payload)
- Average, maximum and minimum frequency deviation (calculated over the packet payload)

RX measurements

For RX measurements, the built-in signal generator generates a selectable bit sequence, which is looped back in the DUT and demodulated and processed by the CMU200 again. The TX level of the CMU200 can be adjusted for this measurement. The BER application allows up to five test programs to be defined. Each program can independently set settings such as control parameters, limits, repetition or statistical cycles.

Sensitivity (single slot packets/multislot packets)

Measurement parameters

- BER (percentage of bit errors that have occurred within the current statistical cycle)

Bluetooth specifications

Standards	Bluetooth Core Specifications Version 1.0 B and 1.1

RF generator

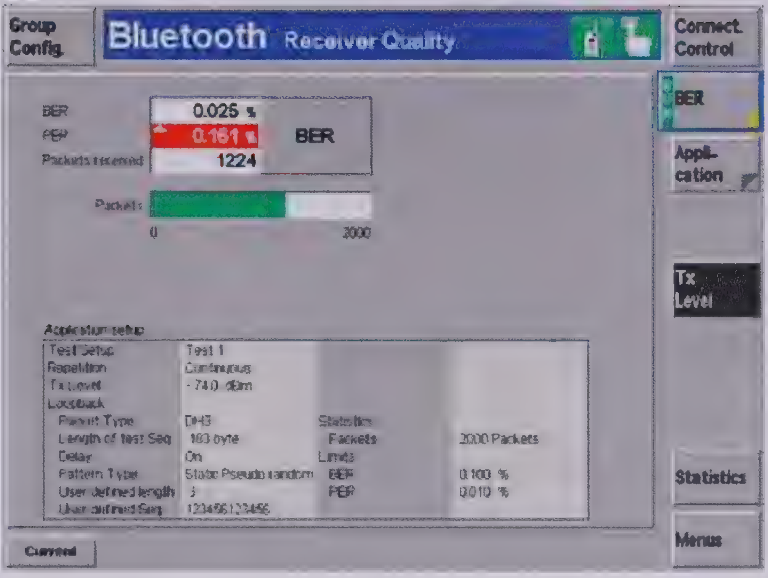
Frequency range	
Europe (except Spain and France), USA and Japan	2.4000 GHz to 2.4835 GHz
France	2.4465 GHz to 2.4835 GHz
Spain	2.4450 GHz to 2.475 GHz
Frequency resolution	channel spacing 1 MHz according to standard
Frequency hopping	all modes according to standard
Output level range (modulated signal)	
RF1	−106 dBm to −33 dBm
RF2	−106 dBm to −12 dBm
RF3OUT	−90 dBm to +5 dBm
Output level resolution	0.1 dB

Output level uncertainty		
	+23°C to +35°C	+5°C to +45°C
RF1, RF2	<0.9 dB	<1.6 dB
RF3OUT	<1.1 dB	<1.6 dB

Modulation	
GFSK (AC coupling cut-off frequency 100 Hz)	1 Mbps, BxT=0.5
Modulation index (11110000 pattern in temperature range +23°C to +35°C)	0.304 to 0.336 plus residual FM (see base unit)

RF analyzer

Frequency range	
Europe (except Spain and France), USA and Japan	2.4000 GHz to 2.4835 GHz
France	2.4465 GHz to 2.4835 GHz
Spain	2.4450 GHz to 2.475 GHz
Frequency resolution	channel spacing 1 MHz according to standard
Frequency hopping	all modes according to standard



BER	0.025 %
PER	0.161 %
Packets received	1224

The receiver quality measurement includes output of BER and PER values. Supports three modes, i.e. single shot, continuous and search of a target BER value, by automatic variation of the CMU 200 output level. Up to 5 different test scenarios can be configured.

- BER search function (sensitivity level for a predefined BER level)
- PER (percentage of packet errors that have occurred within the current statistical cycle, where an errored packet is a packet with a header which cannot be corrected)

Bluetooth wireless technology highlights of CMU 200

- *Bluetooth* test mode signalling
- Full hopping mode measurements
- All packet types (DH 1, 3, 5)
- High measurement accuracy and speed
- Parallel TX and RX measurement of the RF interface in loopback mode
- Output of *Bluetooth*-specific clock signal
- IF signal output
- Graphical and scalar result output

Supported standards

- *Bluetooth* Core Specifications Version 1.0 B and 1.1
- RF Test Specification Version 0.91

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Power meter (frequency-selective) and power versus time

Level Resolution	0.1 dB	
Reference level for full dynamic range (GFSK signal)		
RF1	0 dBm to +41 dBm	
RF2	−14 dBm to +33 dBm	
RF4IN	−32 dBm to 0 dBm	

Level uncertainty from full scale down to −25 dB

	+23°C to +35°C	+5°C to +45°C
RF1, RF2	<0.7 dB	<1.0 dB
RF4IN	<0.9 dB	<1.1 dB
Dynamic range	>55 dB (BW= 3 MHz, rms)	

Modulation analyzer (BW= 3 MHz)

Level range (GFSK signal)	
RF1, RF2, RF4IN	from full-scale setting down to −25 dB
Frequency offset error in preamble	≤2 kHz
Frequency deviation error in payload (for deviation ≤200 kHz)	
for 11110000 pattern	≤2 %
for 10101010 pattern	≤4 %
Total measurement range for frequency offset and frequency deviation	−250 kHz to +250 kHz

Timing measurement

Range	±20 µs
Uncertainty	≤0.25 µs

Base unit specifications

Please see standard-specific data on the previous pages for more details and improved accuracy

Timebase TCXO

Max. frequency drift in temperature range +5 °C to +45 °C	±1 x 10^{-6}
Max. aging	±1 x 10^{-6}/year

Timebase OCXO – option CMU-B11

Max. frequency drift in temperature range +5 °C to+45 °C	±1 x 10^{-7}
Max. aging	±2 x 10^{-7}/year, ±5 x 10^{-9}/day after 30 days of operation
Warmup time (at +25 °C)	approx. 5 min

Timebase OCXO – option CMU-B12

Max. frequency drift in temperature range +5 °C to +45 °C	±5 x 10^{-9}, referred to +25 °C
with instrument orientation	±3 x 10^{-9}
referred to turn off frequency after 2 h warmup time following a 24 h off time at +25 °C	±5 x 10^{-9}
Max. aging	±3.5 x 10^{-8}/year, ±5 x 10^{-10}/day after 30 days of operation
Warmup time (at +25 °C)	approx. 10 min

Reference frequency inputs/outputs

[illegible]	BNC connector REFIN
[illegible]	
[illegible]	1 MHz to 52 MHz, step 1 kHz
[illegible]	10 kHz to 52 MHz, step 1 kHz
[illegible]	±5 x 10^{-6}
[illegible]	0.5 V to 2 V rms
[illegible]	50 Ω
[illegible]	BNC connector REFOUT1
[illegible]	10 MHz from internal reference or frequency [illegible]
[illegible]	[illegible]
[illegible]	[illegible] Ω
[illegible]	[illegible]
[illegible]	[illegible]
	[illegible]
[illegible]	[illegible]
[illegible]	[illegible] Ω

[illegible]

[illegible]	100 kHz to 2700 MHz
[illegible]	0.1 Hz
[illegible]	same as timebase + resolution
[illegible]	<400 µs to Δf <1 kHz

Output level range

RF1	
100 kHz to 2200 MHz	–130 dBm to –27 dBm
2200 MHz to 2700 MHz	–130 dBm to –33 dBm
RF2	
100 kHz to 2200 MHz	–130 dBm to –10 dBm
2200 MHz to 2700 MHz	–130 dBm to –16 dBm
RF3OUT	
100 kHz to 2200 MHz	–90 dBm to +13 dBm
2200 MHz to 2700 MHz	–90 dBm to +5 dBm

Output level uncertainty

RF1, RF2			
in temperature range +23 °C to +35 °C	**≥ –106 dBm**	**> –117 dBm**	**–117 to –130 dBm**
10 MHz to 450 MHz	<0.6 dB		
450 MHz to 2200 MHz	<0.6 dB	<0.6 dB[2]	<1.5 dB[1,2]
2200 MHz to 2700 MHz	<0.8 dB	<0.8 dB[2]	<1.5 dB[1,2]
in temperature range +5 °C to +45 °C	**≥ –106 dBm**	**> –117 dBm**	**–117 to –130 dBm**
10 MHz to 450 MHz	<1.0 dB		
450 MHz to 2200 MHz	<1.0 dB	<1.0 dB[2]	<1.5 dB[1,2]
2200 MHz to 2700 MHz	<1.5 dB	<1.5 dB[2]	<1.5 dB[1,2]

	+23°C to +35°C	+5°C to +45°C
RF3OUT		
10 MHz to 450 MHz, –80 dBm to +10 dBm	<0.8 dB	<1.0 dB
450 MHz to 2200 MHz, –90 dBm to +10 dBm	<0.8 dB	<1.0 dB
2200 MHz to 2700 MHz: –90 dBm to +5 dBm	<1.0 dB	<1.5 dB

Output level settling time	<4 µs
Output level resolution	0.1 dB

Generator RF level repeatability
(RF1, RF2, RF3OUT, typical values after 1 h warmup)

Output ≥–80 dBm	<0.01 dB
Output <–80 dBm	<0.1 dB

VSWR

RF1	
10 MHz to 2000 MHz	<1.2
2000 MHz to 2200 MHz	<1.3
2200 MHz to 2700 MHz	<1.6
RF2	
10 MHz to 2200 MHz	<1.2
2200 MHz to 2700 MHz	<1.6
RF3OUT	
10 MHz to 2200 MHz	<1.5
2200 MHz to 2700 MHz	<1.7

Attenuation of harmonics (f_0 = 10 MHz to 2200 MHz, up to 7 GHz)

RF1, RF2	>30 dB
RF3OUT (P ≤+10 dBm)	>20 dB

Attenuation of nonharmonics

10 MHz to 2200 MHz at >5 kHz from carrier	>40 dB

Phase noise (single sideband, f < 2.2 GHz)

Carrier offset	
20 kHz to 250 kHz	<–100 dBc(1 Hz)
≥250 kHz	<–110 dBc(1 Hz)

Residual FM

30 Hz to 15 kHz	<50 Hz (rms), <200 Hz (peak)
CCITT	<5 Hz (rms)

Residual AM

CCITT	<0.02% (rms)

I/Q modulation
Data for frequency offset range 0 kHz to ±135 kHz

[illegible] suppression	>40 dB

RF analyzer

VSWR

RF1	
10 MHz to 2000 MHz	<1.2
2000 MHz to 2200 MHz	<1.3
2200 MHz to 2700 MHz	<1.6
RF2	
10 MHz to 2200 MHz	<1.2
2200 MHz to 2700 MHz	<1.6
RF4IN	
10 MHz to 2200 MHz	<1.5
2200 MHz to 2700 MHz	<1.6

Power meter (wideband)

Frequency range	100 kHz to 2700 MHz

Level range

RF1	
Continuous power[3]	
100 kHz to 2200 MHz	+6 dBm to +47 dBm (50 W)
2200 MHz to 2700 MHz	+10 dBm to +47 dBm (50 W)
Peak envelope power[4] (PEP)	+53 dBm (200 W)
RF2	
Continuous power	
100 kHz to 2200 MHz	–8 dBm to +33 dBm (2 W)
2200 MHz to 2700 MHz	–4 dBm to +33 dBm (2 W)
Peak envelope power[4] (PEP)	+39 dBm (8 W)
RF4IN (continuous power and PEP)	
100 kHz to 2200 MHz	–33 dBm to 0 dBm
2200 MHz to 2700 MHz	–29 dBm to 0 dBm

---

[1] *Valid for RF1 only.*

[2] *Not valid at frequencies of netclock harmonics.*

[3] *50 W in temperature range +5 °C to +30 °C, linear degradation down to 25 W at 45 °C.*

[4] *Mean value of power vs time must be equal to or less than allowed continuous power.*

Level uncertainty

RF1	+10 dBm to +20 dBm	+20 dBm to +47 dBm
50 MHz to 2700 MHz	<1.0 dB[6]	<0.5 dB[5] [6]
RF2	–4 dBm to +6 dBm	+6 dBm to +33 dBm
50 MHz to 2700 MHz	<1.0 dB[6]	<0.5 dB[6]
RF4IN	–29 dBm to –19dBm	–19 dBm to 0 dBm
50 MHz to 2700 MHz	<1.5 dB	<0.8 dB

Level resolution	0.1 dB (0.01 dB via remote control)

Power meter (frequency-selective)

Frequency range	10 MHz to 2700 MHz
Frequency resolution	0.1 Hz
Resolution bandwidths	10 Hz to 1 MHz in 1/2/3/5 steps

Level range

RF1	
Continuous power[3]	
10 MHz to 2200 MHz	–40 dBm to +47 dBm (50 W)
2200 MHz to 2700 MHz	–34 dBm to +47 dBm (50 W)
Peak envelope power [4] (PEP)	+53 dBm (200 W)
RF2	
Continuous power	
10 MHz to 2200 MHz	–54 dBm to +33 dBm (2 W)
2200 MHz to 2700 MHz	–48 dBm to +33 dBm (2 W)
Peak envelope power [4] (PEP)	+39 dBm (8 W)
RF4IN (continuous power and PEP)	
10 MHz to 2200 MHz	–80 dBm to 0 dBm
2200 MHz to 2700 MHz	–74 dBm to 0 dBm

Level uncertainty

	+23°C to +35°C	+5°C to +45°C
RF1, RF2		
50 MHz to 2200 MHz	<0.5 dB	<1.0 dB
2200 MHz to 2700 MHz	<0.7 dB	<1.0 dB
RF4IN		
50 MHz to 2200 MHz	<0.7 dB	<1.0 dB
2200 MHz to 2700 MHz	<0.9 dB	<1.1 dB

Level resolution	0.1 dB (0.01 dB via remote control)

RF level measurement repeatability
(RF1, RF2, RF4IN, typical values after 1 h warmup)

Input ≥–40 dBm	<0.01 dB
Input <–40 dBm	<0.03 dB

Demodulation (data of hardware paths)

Phase noise (single sideband, f <2.2 GHz)

Carrier offset	
20 kHz to 250 kHz	<–100 dBc(1 Hz)
250 kHz to 400 kHz	<–110 dBc(1 Hz)
≥400 kHz	<–118 dBc(1 Hz)

Residual FM

30 Hz to 15 kHz	<50 Hz (rms), <200 Hz (peak)
CCITT	<5 Hz (rms)

Residual AM

CCITT	<0.02% (rms)

Spectrum analyzer

Frequency range	10 MHz to 2.7 GHz
Span	zero span to full span
Frequency resolution	0.1 Hz
Resolution bandwidths	10 Hz to 1 MHz in 1/2/3/5 steps
Sweep time	≥100 ms, depending on RBW
Display	560 dots, horizontal
Marker	up to 3, absolute/relative
Display line	1
Display scale	10/20/30/50/80/100 dB

Level range

RF1	
Continuous power[3]	up to +47 dBm (50 W)
Peak envelope power[4] (PEP)	up to +53 dBm (200 W)
RF2	
Continuous power	up to +33 dBm (2 W)
Peak envelope power[4] (PEP)	up to +39 dBm (8 W)
RF4IN (continuous power and PEP)	up to 0 dBm

Level uncertainty

	+23°C to +35°C	+5°C to +45°C
RF1, RF2		
50 MHz to 2200 MHz	<0.5 dB	<1.0 dB
2200 MHz to 2700 MHz	<0.7 dB	<1.0 dB
RF4IN		
50 MHz to 2200 MHz	<0.7 dB	<1.0 dB
2200 MHz to 2700 MHz	<0.9 dB	<1.1 dB

Reference level for full dynamic range (low noise mode)

Logarithmic level display	
RF1	+10 dBm to +47 dBm
RF2	–4 dBm to +33 dBm
RF4IN	–22 dBm to 0 dBm

Displayed average noise level (RBW 1 kHz, low noise mode)

RF1/RF2/RF4IN	
10 MHz to 2200 MHz	<–100 dBc
2200 MHz to 2700 MHz	<–95 dBc

Inherent spurious response	<–50 dB

Low distortion mode, 20 MHz to 2200 MHz, except 1816.115 MHz

Inherent harmonics
(f_0 = 50 MHz to 2200 MHz, up to 7 GHz)

RF1, RF2	<–30 dB
RF4IN	<–20 dB

Audio option CMU-B41

AF generator

Output impedance	<4 Ω
Maximum output current	20 mA (peak)

AF sine generator

Frequency range	20 Hz to 20 kHz
Frequency uncertainty	same as time base + half resolution
Frequency resolution	0.1 Hz
Output level range	10 µV to 5 V
Output level resolution	
at level <10 mV	10 µV
at level ≥10 mV	0.1%
Output level uncertainty	
at level ≥1 mV and frequency ≤10 kHz	≤1.5% + resolution
THD+N[7]	
at level ≥100 mV into load ≥600 Ω	≤0.05%
THD[7]	
at level ≥100 mV into load ≥600 Ω	≤0.025%

AF analyzer

Input impedance	1MΩ ǀǀ 100 pF

AF voltmeter

Frequency range	50 Hz to 20 kHz
Level range	50 µV to 30 V
Level resolution	
at level <1 mV	1 µV
at level ≥1 mV	0.1%
Level uncertainty	
at 1 mV ≤ level ≤ 2 V	<1% + resolution
at 2 V < level ≤20 V	<2% + resolution

THD+N meter

Measurement bandwidth	21 kHz
Frequency range	100 Hz to 10 kHz
Level range	10 mV to 30 V
Resolution	0.01% THD+N
Inherent distortion	
at 100 mV ≤ level ≤ 20 V	<0.05% THD+N
Uncertainty	
at 100 mV ≤ leve l≤ 2 V	<1% + inherent distortion
at 2 V <level ≤20 V	<2% + inherent distortion

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[5] *Calibrated for P>33 dBm only in frequency range 800 MHz to 2000 MHz.*

[6] *Temperature range +5°C to +23 °C or +35 °C to +45 °C and f>2200 MHz: add 0.2 dB.*

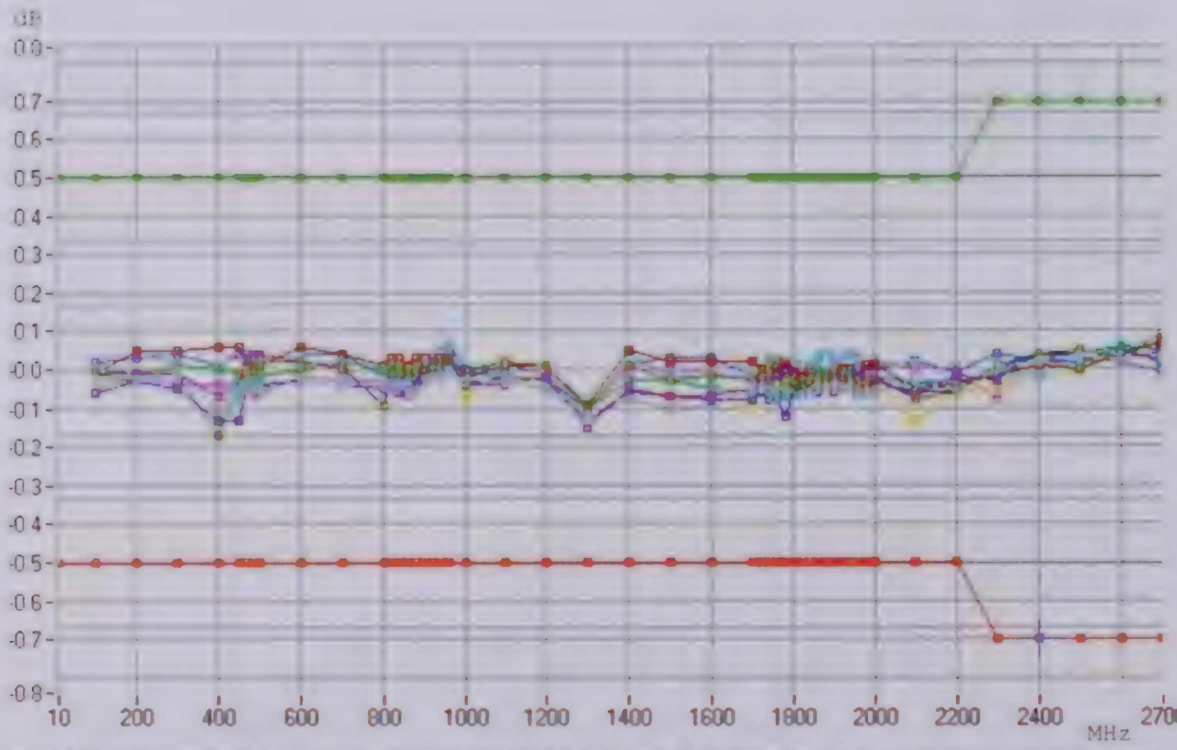
[7] *Measurement bandwidth: 21.9 kHz.*

General data

Rated temperature range	+5 °C to +45 °C
Storage temperature range	–25 °C to +60 °C
Humidity	+40 °C, 80% rh, non-condensing; complies with IEC 68-2-3
Display	21 cm TFT colour display (8.4")
Resolution	640 x 480 pixels (VGA resolution)
Pixel failure rate	$<2 \times 10^{-5}$
Electromagnetic compatibility	meets requirements of EMC Directive 89/336/EEC (EN50081-1 and EN50082-2) meets requirements of EN61326-1
Mechanical resistance (non-operating mode)	
Vibration, sinusoidal	meets IEC68-2-6, IEC1010-1, EN61010-1, MIL-T-28800 D class 5, 5 Hz to 150 Hz, max. 2 g at 55 Hz, 55 Hz to 150 Hz, 0.5 g const.
Vibration, random	meets DIN IEC 68-2-36, DIN 40046 T24 10 Hz to 300 Hz, acceleration 1.2 g rms
Shock	meets DIN IEC 68-2-27, MIL-STD-810D 40 g shock spectrum
Electrical safety	IEC1010-1, DIN EN61010-1, UL3111-1, CSA22.2 No. 1010.1
Power supply	100 V to 240 V ± 10% (AC), 50 Hz to 400 Hz –5% to +10% power factor correction, EN61000-3-2 power consumption: max. 500 VA, base unit 130 W typ. with options 180 W typ.
Dimensions (W x H x D)	465 mm x 193 mm x 517 mm (19"; 4 height units)
Weight	
Base unit	14 kg
With typical options	18 kg

Inputs and outputs (rear panel)

IF3 RX CH1	Z_{out} = 50 Ω, BNC female, max. level –2 dBm, 10.7 MHz
Remote control interfaces	
IEC/IEEE bus	IEC 625-2 (IEEE 488.2) 24-pin Amphenol connector
Serial interface COM1, COM2	RS-232-C (COM), 9-pin sub-D connector
Printer interface LPT	parallel (Centronics compatible), 25-pin sub-D connector
Keyboard	PS/2 connector
External monitor (VGA)	15-pin sub-D connector



Rohde & Schwarz specifications are a conservative view of what a product has to offer. As an example, this diagram presents the accuracy of the CMU200 frequency-selective power measurement. It is shown here for 10 randomly chosen instruments at 25°C and 0 dBm on RF2 without taking additional measurement uncertainty from the test system itself into account. The tolerances marked above and below (green and red line) indicate the specifications stated in this data sheet's general data section.

Models and options

Instruments, options and ordering information

continued on the next page

Type/Option	Description	GSM/GPRS/ EDGE/HSCSD	TDMA	AMPS	cdmaOne	CDMA2000	WCDMA	Bluetooth	Order number
CMU 200	Base unit with following accessories: power cord, operating manual, service manual instrument	✓	✓	✓	✓	✓	✓	✓	1100.0008.02
CMU-B11[1]	Reference OCXO, aging 2 x 10^{-7}/year. Ensures high absolute accuracy, minimum temperature-dependent drift and especially high long-term stability. Used for measurements with exact frequency stability requirements	☺	☺	☺	☺	☺	☺	☺	1100.5000.02
CMU-B12[1]	High-stability OCXO, aging 3.5 x 10^{-8}/year. Oven crystal with highest long-term stability. Ensures compliance with tolerances specified by GSM. Used for highly demanding frequency stability requirements to GSM 11.20	☺	☺	☺	☺	☺	☺	☺	1100.5100.02
CMU-B17	I/Q IF interface	☺	☺	–	–	☺	☺	–	1100.6906.02
CMU-B21	Versatile signalling unit. Provides multistandard signalling hardware	✓	✓	✓	–	–	–	✓	1100.5200.02
CMU-B41	Audio generator and analyzer. Includes audio frequency (AF) generator, voltmeter, distortion meter	☺	☺	✓	–	☺	–	–	1100.5300.02
CMU-B52[2]	Internal versatile multimode speech coder/decoder. This option converts digital speech signals into analog signals and vice versa. The option allows separate uplink and downlink audio application measurements on mobile phones.	☺	☺	–	–	–	–	–	1100.5400.02
CMU-B53[2][13]	Bluetooth extension	–	–	–	–	–	–	✓	1100.5700.02
CMU-B66[13]	Versatile baseband board	–	–	–	–	–	✓	–	1149.9509.02
CMU-B81	cdmaOne signalling unit	–	–	–	✓	–	–	–	1100.6506.02
CMU-B83	CDMA2000 (1x) signalling unit	–	–	–	–	✓	–	–	1150.0301.02
CMU-B99	RF1 level range identical to RF2	☺	☺	☺	☺	☺	☺	☺	1150.1250.02
CMU-U53[2][6]	Bluetooth upgrade kit	–	–	–	–	–	–	✓	1100.7302.02
CMU-U61[14]	Modification kit: floppy disk drive 3½" instead of PCMCIA	☺	☺	☺	☺	☺	☺	☺	1100.5500.02
CMU-U65	3G measurement DSP	–	–	–	–	✓	✓	–	1100.7402.02
CMU-U66[13]	Upgrade kit Versatile baseband board	–	–	–	–	–	✓	–	1149.9609.02
CMU-U83[13]	Upgrade kit to CMU-B83 in exchange for CMU-B81	–	–	–	–	✓	–	–	1150.0401.02
CMU-U99[12]	Modification kit RF1 level range identical to RF2	☺	☺	☺	☺	☺	☺	☺	1150.1350.02
CMU-K20[2][7]	GSM400 mobile station signalling/non-signalling test	✓	–	–	–	–	–	–	1115.5900.02
CMU-K21[2][7]	GSM900, R-GSM and E-GSM mobile station signalling/non-signalling test	✓	–	–	–	–	–	–	1115.6007.02
CMU-K22[2][7]	GSM1800 (DCS) mobile station signalling/non-signalling test	✓	–	–	–	–	–	–	1115.6107.02
CMU-K23[2][7]	GSM1900 (PCS) mobile station signalling/non-signalling test	✓	–	–	–	–	–	–	1115.6207.02
CMU-K24[2][7]	GSM850 mobile station signalling/non-signalling test	✓	–	–	–	–	–	–	1115.6307.02
CMU-K27[2][7]	IS-136/Cellular (800 MHz band) mobile station signalling/non-signalling test	–	✓	–	–	–	–	–	1115.6607.02
CMU-K28[2][7]	IS-136/PCS (1900 MHz band) mobile station signalling/non- signalling test	–	✓	–	–	–	–	–	1115.6707.02
CMU-K29[3]	AMPS mobile station signalling/non-signalling test	–	–	✓	–	–	–	–	1115.6807.02
CMU-K42[11]	GPRS software extension for all GSM software packages	✓	–	–	–	–	–	–	1115.4691.02
CMU-K53[2][5]	Bluetooth test software	–	–	–	–	–	–	✓	1115.5000.02
CMU-K65[8]	WCDMA (3GPP/FDD, UL) user equipment TX test, non-signalling	–	–	–	–	–	✓	–	1115.4891.02
CMU-K66[8][9]	WCDMA (3GPP/FDD, DL) generator software	–	–	–	–	–	✓	–	1115.5100.02
CMU-K81[4][7]	cdmaOne cellular (800 MHz band) mobile station signalling/non-signalling test	–	–	–	✓	–	–	–	1115.5500.02
CMU-K82[4][7]	cdmaOne PCS (1700/1900 MHz band) mobile station signalling/non-signalling test	–	–	–	✓	–	–	–	1115.5600.02
CMU-K83[10][7]	CDMA2000 (1x) (450 MHz band) mobile station signalling/non-signalling test	–	–	–	–	✓	–	–	1150.3500.02
CMU-K84[10][7]	CDMA2000 (1x) (cellular band) mobile station signalling/non-signalling test	–	–	–	–	✓	–	–	1150.3600.02
CMU-K85[10][7]	CDMA2000 (1x) (PCS band) mobile station signalling/non-signalling test	–	–	–	–	✓	–	–	1150.3700.02
CMU-K86[10][7]	CDMA2000 (1x) (IMT2000 band) mobile station signalling/non-signalling test	–	–	–	–	✓	–	–	1150.3800.02

Comments on table:
✓ mandatory; ☺ optional; – not applicable

[1] *CMU-B11 or CMU-B12 possible. One of two OCXOs should be installed to ensure high frequency accuracy or external frequency reference may be used, if available*

[2] *CMU-B21 necessary*

[3] *CMU-B21 and CMU-B41 necessary*

[4] *CMU-B81 necessary*

[5] *CMU-B53 necessary*

[6] *For upgrade only if factory installation is not applicable. Includes CMU-B53 and CMU-K53.*

[7] *Depending on the required frequency band.*

[8] *CMU-U65 necessary.*

[9] *CMU-U66 or CMU-B66 necessary.*

[10] *CMU-B83 or CMU-U83 necessary.*

[11] *At least one of CMU-K20 to K24 necessary.*

[12] *Factory installation only.*

[13] *For upgrade only if factory installation is not applicable*

[14] *For new units only. Factory installation only*

Type/Option	Description	GSM	TDMA	AMPS	cdmaOne	CDMA2000	WCDMA	Bluetooth	Order number
BW2-C1	Corner cover 1 (2 pieces required)	☺	☺	☺	☺	☺	☺	☺	1096 2593 00
BW2-C2	Corner cover 2 (2 pieces required)	☺	☺	☺	☺	☺	☺	☺	1096 2602 00
CMU-DCV	Documentation of calibration values	☺	☺	☺	☺	☺	☺	☺	0240 2193 08
CRT-Z2	GSM (phase 2) test SIM [illegible] required for [illegible] and other applications	☺	–	–	–	–	–	–	1039 9005 02
CMU-Z1	[illegible] PCMCIA interface	☺	☺	☺	☺	☺	☺	☺	1100 7490 02
CMU-Z6	Enhancement of wideband [illegible]	–	–	–	–	–	☺	–	1150 0001 02
CMU-Z10	Antenna coupler [illegible] MHz [illegible] MHz	☺	☺	☺	☺	☺	☺		1150 0801 02
CMU-Z11	Shielded [illegible] CMU-Z10	☺	☺	☺	☺	☺	☺		1150 1008 02
CMU-Z12	Bluetooth antenna	–	–	–	–	–	–	☺	1150 1043 02
PSM-B9	[illegible]	☺	☺	☺	☺	☺	☺	☺	1064 5700 02
ZZA-411	19" rack adapter	☺	☺	☺	☺	☺	☺	☺	1096.3283.00

Comments on table:
✓ mandatory, ☺ optional, – not applicable

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ROHDE&SCHWARZ GmbH & Co. KG · Mühldorfstraße 15 · 81671 München · Germany · P.O.B. 80 14 69 · 81614 München · Germany · Telephone +49 89 41 29-0
www.rohde-schwarz.com · Customer Support: Tel. +49 1805 12 42 42, Fax +49 89 41 29-137 77, E-mail: CustomerSupport@rohde-schwarz.com

Value-added services

- Rohde&Schwarz offers a wide range of training programs not only on products but also on new technical developments
- Rohde&Schwarz application engineers help to optimize the use of the CMU 200 and the overall performance of your local environment
- Over 70 representative offices and a tight worldwide network of service and calibration centers ensure Rohde&Schwarz support where you need it

Quality management at Rohde&Schwarz

Lasting customer satisfaction is our primary objective. The quality management system of Rohde&Schwarz meets the requirements of ISO 9001 and encompasses virtually all fields of activity of the company.

Certified Quality System
ISO 9001
DQS REG. NO 1954

Certified Environmental System
ISO 14001
REG. NO 1954

Basics
Technology
Solutions

GSM
GPRS
HSCSD
EDGE

TDMA

AMPS

cdmaOne

CDMA2000

WCDMA

Bluetooth

Product Brochure

WCDMA
GPRS
EDGE
GSM
UNIVERSAL RADIO COMMUNICATION TESTER CMU 300
WCDMA FDD Code Domain Power

Version 01.00

July 2003

Universal Radio Communication Tester R&S® CMU 300

The base station tester for current and future mobile radio networks

- Extremely high-speed testing
- Highly accurate measurements
- Modular future-proof design
- Comprehensive spectrum analyzer and signal generator

Now with WCDMA support

ROHDE&SCHWARZ

The R&S CMU 300 – a new generation in base station testing

Rohde & Schwarz milestones in digital testing

1990 R&S CMTA94 [illegible]

1991 R&S CRTS02/04 Signalling tester for GSM mobile and base stations

1992 R&S FTA [illegible]

1993 R&S ITA [illegible]

1994 R&S CMD55/57 The world's [illegible]

1996 R&S CRTP C02 Approved as [illegible]

1997 R&S TS8915 Supplier of the first [illegible] test system for GSM 1900

1997 R&S CMD65 The world's first com[illegible]

1999 R&S CMU200 The cellphone tester for current and future mobile radio networks

2000 R&S CMU300 [illegible] for current and future mobile radio networks

Rohde & Schwarz has always been at the forefront of mobile radio technology. For 70 years now we are developing solutions for our customers.

The R&S CMU 300 carries on this tradition. As a high-end communication tester platform for base stations it completes the Rohde & Schwarz product portfolio.

The R&S CMU 300 reflects the long-standing expertise Rohde & Schwarz has gained in the world of mobile communication and base station testing in different fields such as production, R&D, commissioning, system test, service and maintenance.

The R&S CMU 300 is designed to provide a flexible platform for customized solutions and testing with maximum speed, top accuracy and optimum repeatability. Its home is the world of digital mobile networks of generations 2, 2.5 and 3.

Ask your local Rohde & Schwarz representative for a demonstration and help to find out about your requirements.

The R&S CMU 300 can handle a wide range of applications, but is primarily optimized for the high accuracy and speed demanded in an ever more quality-conscious manufacturing process. The picture shows the front panel for desktop use.

Key strengths

The Radio Communication Tester R&S CMU300 ensures premium cost effectiveness through a variety of features, with extremely fast measurement speed and very high accuracy being the two most important ones. In addition, the secondary remote addressing of the unit's modular architecture makes for intelligent and autonomous processing of complete measurement tasks and fast control program design.

Greatest accuracy

In a production environment the unit's high accuracy allows DUTs (devices under test) to be tested for optimal mobile network performance. In the lab, the R&S CMU300 enables the development engineer to replace conventional, dedicated premium-quality instruments more often than any other radio communication tester and save desktop space at the same time. High-precision measurement correction over the whole frequency and dynamic range as well as compensation for temperature effects in realtime are critical factors for achieving the R&S CMU300's excellent accuracy.

The new, globally standardized, Rohde&Schwarz calibration system can check the R&S CMU300's accuracy in a service center close to you or, volume permitting, on your premises. A worldwide network of these standardized automatic calibration systems has been implemented in our service centers. Highly accurate and repeatable calibration can be performed wherever you are. Your local Rohde&Schwarz representative offers customized service contracts for the unit.

Greatest speed

The high processing speed is due to extensive use of ProbeDSP™ technology, parallel measurements and innovative remote command processing. These three aspects of the performance of the R&S CMU300 are explained in more detail below.

ProbeDSP™ technology

The modular architecture relies on decentralized ProbeDSP™ processing coordinated by a powerful central processor. Like an oscilloscope probe, DSPs dedicated to a specific local data acquisition and evaluation workload help to keep subsystem performance at an uncompromised maximum even if additional modules are fitted to the R&S CMU300 mainframe.

Innovative remote processing

The novel secondary addressing mode can address similar functions of each of the R&S CMU300's subsystems (different mobile radio standards) in an almost identical way. Using this type of addressing, new remote test sequences can be programmed by a simple cut and paste operation followed by editing specific commands to adapt the control program to the new application. Secondary addressing is fully SCPI-compliant, which means that a subsystem address, for example "GSM 1800", can be replaced by a string denoting a different subsystem (another mobile radio standard).

Key advantages of the R&S CMU300

Speed

- Single measurement up to 10 times faster than with the previous generation of instruments

Accuracy

- Three times more accurate than the previous generation of instruments with excellent repeatability

Modularity

- Modular hardware and software concept providing easy extension to enhanced functionality

Bullet-proof

- Low component count, low power consumption, and effective heat conduction for unparalleled reliability

Future-proof

- Easy migration to future standards

Greatest reliability

The keys to the high reliability of the R&S CMU300 are the low power intake and the innovative cooling concept. Less power means less heat. Power consumption is way below 200 W due to specially selected low-power components, the minimum component count concept, plus low voltage design wherever possible.

The R&S CMU300 employs an ultra-effective heat management between housings and individual components as well as between heat sinks and air flow. Independent cooling cycles for the front module controller, the power supply unit and the RF frontend add up to an optimized cooling system.

Base unit

As the R&S CMU300 has a modular architecture, the base unit comes without any network- or standard-specific hardware and software. The base unit can be used for testing the general parameters of RF modules at early production stages. Constituent parts of the R&S CMU300 base unit are the RF generator and RF analyzer, which are completed by a versatile network-independent time domain menu and a comprehensive spectrum analyzer.

Besides the convenient operational concept, the spectrum analyzer stands out for a continuous frequency range (10 MHz to 2.7 GHz) and several selectable resolution bandwidths. The zero span mode represents a separate operation group with sophisticated trigger and timing functions (pre-trigger, delay, timebase, slope).

The RF switching matrix is one of the R&S CMU300's highlights. It is located directly behind the connectors and yields a superior VSWR of better than 1:1.2. The instrument can be easily adjusted to the DUT by means of four flexible N connectors. Two connectors (RF1, RF2) are configurable as duplex RF interfaces. One connector is for high power base stations up to +47 dBm, and the other one is for micro base stations with a maximum output power of +33 dBm. In addition, the instrument is equipped with a high power output (RF3 OUT; up to +13 dBm) and a sensitive input (RF4 IN; –80 dBm to 0 dBm). The power of incoming RF signals can thus be analyzed in the range from +47 dBm down to –80 dBm. Signals from –130 dBm up to +13 dBm can be generated for receiver tests.

The rear-panel reference input and output is the prerequisite for minimizing systematic frequency errors during measurement. It is fitted as standard. Besides the IEEE and RS-232-C interface the base unit is equipped with two PCMCIA slots.

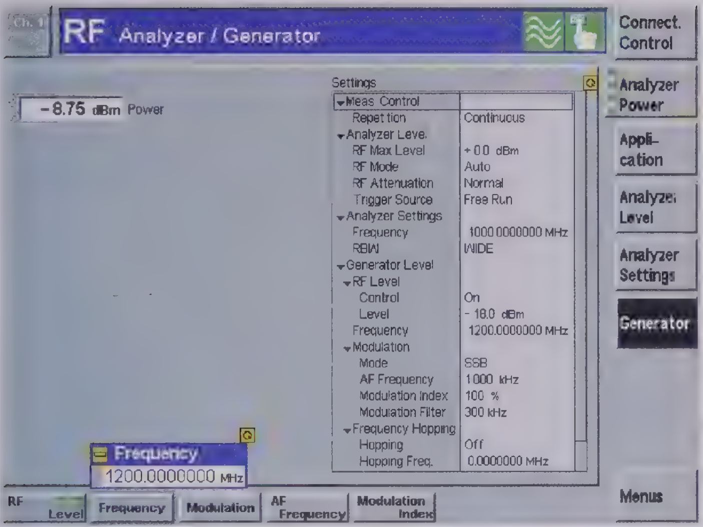
Operation

The instrument can be operated either manually or via the IEC/IEEE bus. The hierarchical menu structures in conventional communication testers have been replaced by context-sensitive selection, entry and configuration pop-up menus, which results in a uniquely flat menu structure.

Owing to the high resolution of the extremely bright high-contrast TFT display even the finest details can be displayed.

To increase speed, measurements that are not required can be switched off, which frees resources for the measurement you want to focus on.

Advanced operational ergonomics have been incorporated into a most compact package. Even with the rackmount kit, the R&S CMU300 does not exceed four height units.


RF Analyzer / Generator
Connect. Control
Analyzer Power
Application
Analyzer Level
Analyzer Settings
Generator
Menus
RF Level
Frequency
Modulation
AF Frequency
Modulation Index

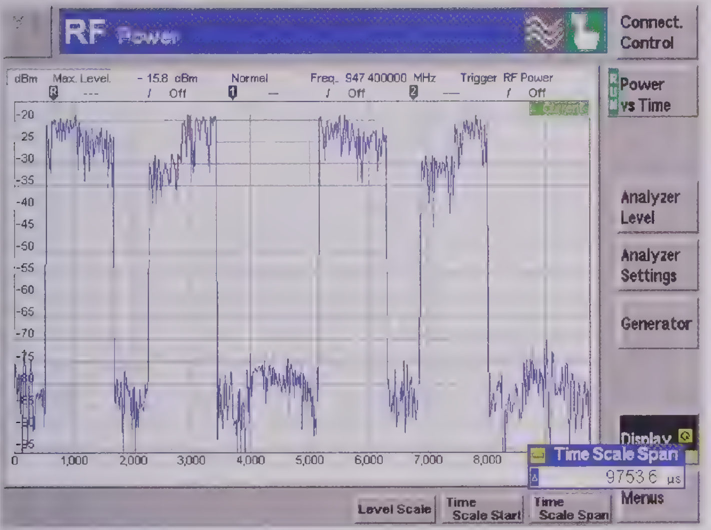
-8.75 dBm Power

Frequency 1200.0000000 MHz

Settings

Meas. Control	
Repetition	Continuous
Analyzer Level	
RF Max Level	+0.0 dBm
RF Mode	Auto
RF Attenuation	Normal
Trigger Source	Free Run
Analyzer Settings	
Frequency	1000.0000000 MHz
RBW	WIDE
Generator Level	
RF Level	
Control	On
Level	-18.0 dBm
Frequency	1200.0000000 MHz
Modulation	
Mode	SSB
AF Frequency	1.000 kHz
Modulation Index	100 %
Modulation Filter	300 kHz
Frequency Hopping	
Hopping	Off
Hopping Freq.	0.0000000 MHz

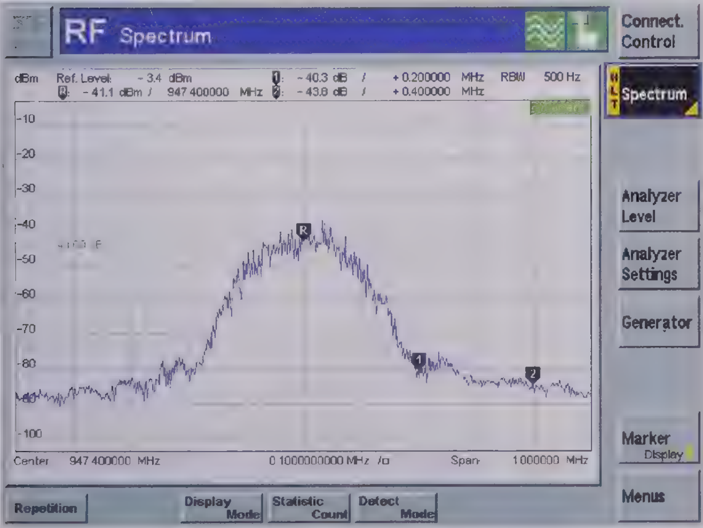
The base unit incorporates generic RF analyzer / generator functions


RF Power
Connect. Control
Power vs Time
Analyzer Level
Analyzer Settings
Generator
Display
Menus
Level Scale
Time Scale Start
Time Scale Span
dBm
-20
25
-30
-35
-40
-45
-50
-55
-60
-65
-70
-75
-80
-85
-90
-95
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000

Max. Level -15.8 dBm Normal Freq. 947.400000 MHz Trigger RF Power

Time Scale Span 9753.6 µs

The zero span mode of the spectrum analyzer is optimized for all kinds of RF signals


RF Spectrum
Connect. Control
Spectrum
Analyzer Level
Analyzer Settings
Generator
Marker Display
Menus
Repetition
Display Mode
Statistic Count
Detect Mode
dBm
-10
-20
-30
-40
-50
-60
-70
-80
-100
R
1
2

Ref. Level: -3.4 dBm
R: -41.1 dBm / 947.400000 MHz
1: -40.3 dB / +0.200000 MHz
2: -43.8 dB / +0.400000 MHz
RBW 500 Hz

Center 947.400000 MHz 0.1000000000 MHz /div Span 1.000000 MHz

The spectrum analyzer provides several marker functions for a comprehensive investigation of the signal applied

GSM/EDGE test modes

Tailor-made with options

The basic version of the R&S CMU300 already offers signal generator and spectrum analyzer functionality. It is converted into a GSM radiocommunication tester (transmitter and receiver measurements for GMSK modulation) by adding the R&S CMU-B21 hardware option (signalling unit) and at least one of the five GSM software options.

- GSM400 (R&S CMU-K30)
- GSM850 (R&S CMU-K34)
- GSM900 (R&S CMU-K31)
- GSM1800 (R&S CMU-K32)
- GSM1900 (R&S CMU-K33)

In this way – as an essential feature – all GPRS channel coders are available in the R&S CMU300. The GSM functionalities can be extended to EDGE (TX and RX test functionality) by means of the R&S CMU-K41 software option, which also adds EGPRS channel coders. The R&S CMU-K39 software option allows link setup using the standard call procedures MOC/MTC (mobile originated/terminated call). The available hardware options include a highly accurate, oven-controlled crystal (R&S CMU-B12) and an A_{bis} board (R&S CMU-B71). The latter is needed for BER tests where the bit pattern sent by the R&S CMU300 is returned to the R&S CMU300 via the A_{bis} interface.

Non-signalling mode

This mode is particularly suitable for testing RF boards/modules with little or no signalling activity. The measurement starts completely independently from external trigger signals or signalling information. As soon as RF power is applied to the input, the tester starts to sample the incoming RF signal. When the corresponding RF parameters are calculated and displayed, the instrument is ready for the next measurement. All GSM/EDGE-specific TX measurements on signals with appropriate modulation scheme and midamble are available. In addition, the R&S CMU300 is able to generate signals with GSM/EDGE-specific midamble and modulation in the entire frequency range from 10 MHz to 2.7 GHz. The analyzer and generator functionalities are not linked, i.e. any channel spacing between uplink and downlink signals is possible.

Signalling mode

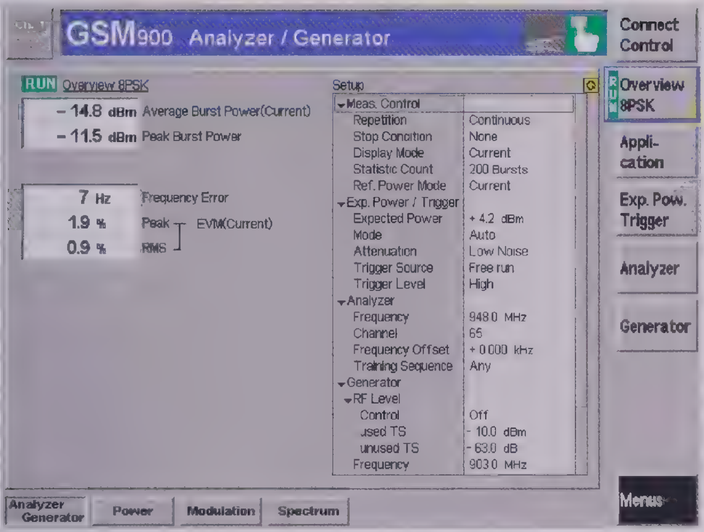
The signalling mode is provided for testing modules or base stations supporting a certain level of signalling. In this mode, the tester operates synchronously to the BTS, i.e. it is synchronized to the TDMA frame structure, which is vital for receiver bit-error-rate measurement. All transmitter parameters can be tested separately for each timeslot. This function is necessary for testing base stations that support both GSM and EDGE. The ability to code / decode channels in realtime is the basis for synchronized measurements. The instrument can be synchronized to the base station in the following ways:

- If the BTS has a multiframe clock output, the signal can be used to trigger the R&S CMU300. An additional trigger line has to be taken into consideration. For BER tests and EDGE TX tests the 26 multiframe trigger is required.
- If only the RF connection is used, the tester can synchronize to the C0 carrier of the base station, just like a mobile phone. This simplifies the test setup. However, a CCH carrier including FCCH/SCH channels and system information 1 to 4 must be activated in the BTS before measuring the used traffic channel.

After successful synchronization there is permanent resynchronization to SACCH of TCH.

Call setup

In the signalling mode, the R&S CMU300 is able to provide a mobile simulation (optional) with mobile originated call (MOC), mobile terminated call (MTC) and location update procedures. This is necessary whenever the complete signalling of the BTS air interface is to be tested, the BTS is in slow frequency hopping (SFH) mode or the BTS measurement reports have to be checked. During location update, MOC and MTC, the layer 3 messages exchanged between the R&S CMU300 and the base station are shown on the TFT display. The IMEI and IMSI numbers of the simulated mobile (R&S CMU300) must be entered manually, no SIM card being used.


GSM900 Analyzer / Generator
Connect Control
Overview 8PSK
Appli- cation
Exp. Pow. Trigger
Analyzer
Generator
Menus
Analyzer Generator
Power
Modulation
Spectrum
RUN

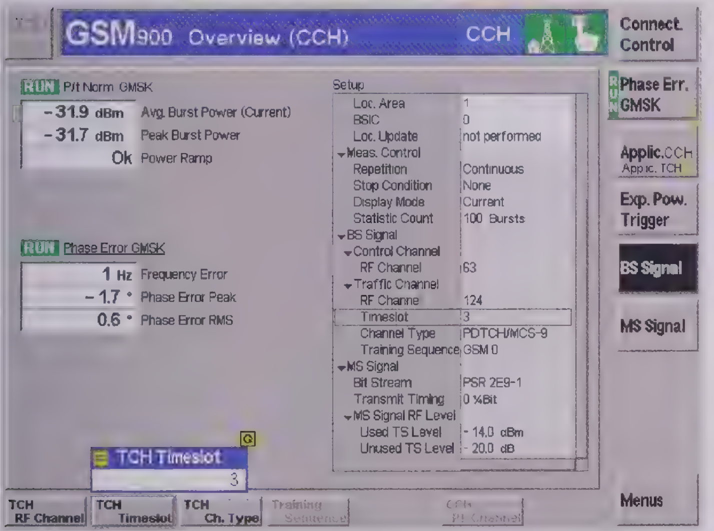
Overview 8PSK

– 14.8 dBm	Average Burst Power(Current)
– 11.5 dBm	Peak Burst Power
7 Hz	Frequency Error
1.9 %	Peak EVM(Current)
0.9 %	RMS EVM(Current)

Setup

Meas. Control	
Repetition	Continuous
Stop Condition	None
Display Mode	Current
Statistic Count	200 Bursts
Ref. Power Mode	Current
Exp. Power / Trigger	
Expected Power	+ 4.2 dBm
Mode	Auto
Attenuation	Low Noise
Trigger Source	Free run
Trigger Level	High
Analyzer	
Frequency	948.0 MHz
Channel	65
Frequency Offset	+ 0.000 kHz
Training Sequence	Any
Generator	
RF Level	
Control	Off
used TS	- 10.0 dBm
unused TS	- 63.0 dB
Frequency	903.0 MHz

The non-signalling mode allows GMSK/8PSK signals to be generated and analyzed for RX/TX module testing; the hotkeys at the bottom of the screen give immediate access to specific measurements


GSM900 Overview (CCH)
CCH
Connect Control
Phase Err. GMSK
Applic. CCH
Applic. TCH
Exp. Pow. Trigger
BS Signal
MS Signal
Menus
TCH RF Channel
TCH Timeslot
TCH Ch. Type
Training Sequence
CCH PL Channel
RUN

P/t Norm GMSK

– 31.9 dBm	Avg. Burst Power (Current)
– 31.7 dBm	Peak Burst Power
Ok	Power Ramp

Phase Error GMSK

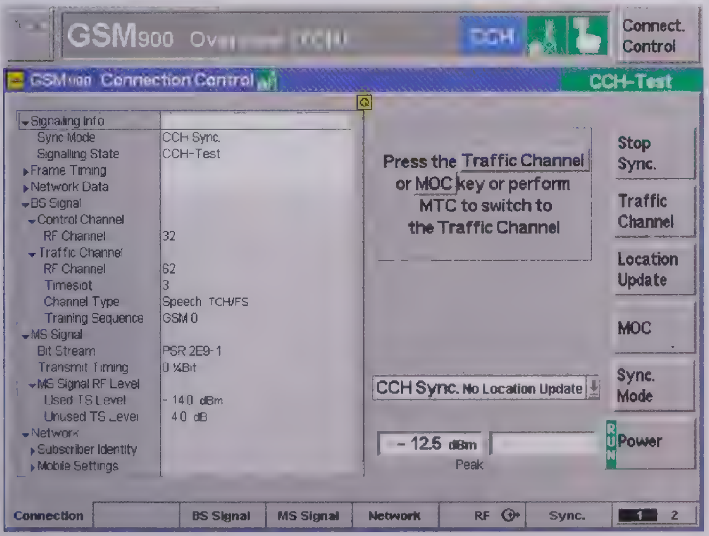
1 Hz	Frequency Error
– 1.7 °	Phase Error Peak
0.6 °	Phase Error RMS

TCH Timeslot 3

Setup

Loc. Area	1
BSIC	0
Loc. Update	not performed
Meas. Control	
Repetition	Continuous
Stop Condition	None
Display Mode	Current
Statistic Count	100 Bursts
BS Signal	
Control Channel	
RF Channel	63
Traffic Channel	
RF Channel	124
Timeslot	3
Channel Type	PDTCH/MCS-9
Training Sequence	GSM 0
MS Signal	
Bit Stream	PSR 2E9-1
Transmit Timing	0 ¼Bit
MS Signal RF Level	
Used TS Level	- 14.0 dBm
Unused TS Level	- 20.0 dB

The signalling mode overview menu informs the user quickly and comprehensively about the BTS's TCH RF performance; timeslot selective measurements are possible


GSM900 Overview (CCH)
CCH
Connect. Control
GSM900 Connection Control
CCH-Test
Stop Sync.
Traffic Channel
Location Update
MOC
Sync. Mode
Power
RUN
Connection
BS Signal
MS Signal
Network
RF
Sync.
1
2

Signaling Info	
Sync Mode	CCH Sync.
Signalling State	CCH-Test
Frame Timing	
Network Data	
BS Signal	
Control Channel	
RF Channel	32
Traffic Channel	
RF Channel	62
Timeslot	3
Channel Type	Speech TCH/FS
Training Sequence	GSM 0
MS Signal	
Bit Stream	PSR 2E9-1
Transmit Timing	0 ¼Bit
MS Signal RF Level	
Used TS Level	- 14.0 dBm
Unused TS Level	4.0 dB
Network	
Subscriber Identity	
Mobile Settings	

Press the Traffic Channel or MOC key or perform MTC to switch to the Traffic Channel

CCH Sync. No Location Update

– 12.5 dBm Peak

There are different possibilities for setting up the channel to be measured in the Connection Control pop-up menu

GSM/EDGE RX (BER) measurements

Principles

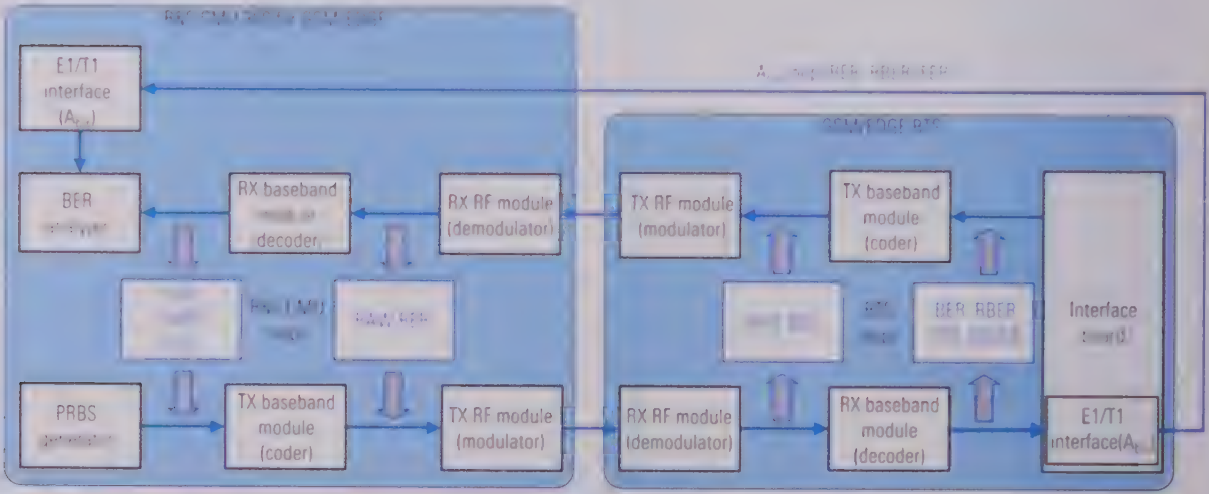
When it comes to receiver characteristics, the physical effects appear in the DUT itself, so no direct measurement is possible. The GSM standardization committees therefore defined test methods for measuring the receiver characteristics of GSM/EDGE BTSs. According to these test methods there are two logical reference points inside the BTS where the receiver quality must be defined. These reference points are located behind the demodulator and behind the channel decoder. The basic principle of bit error ratio (BER) testing is simple. The R&S CMU300 sends a data stream to the BTS, which then sends it back to the tester (loop); i.e. the signal to be analyzed is forwarded from the reference point inside the BTS to the external BER analyzer by means of different loops. The R&S CMU300 compares the sent and received uncoded data bits to determine the number of bit errors. Two essentially different loops are used.

- The BTS is set to close its RF loop directly after the logical reference points. The received data is returned on the RF downlink path. The benefit of this measurement principle is that no extra cabling is needed besides the "ordinary" RF connection. This approach is an easy way of testing the most important GSM/EDGE channel types.
- Using the A_{bis} loop the decoded signal is forwarded to the BER analyzer via the A_{bis} output of the BTS. This test path is often required when there is no possibility for loop activation inside the BTS.

Absolute receiver sensitivity
Based on realtime BER capability the user can directly vary the transmitter level during the test by means of numerical entry or the spinwheel. This is a fast and easy way to determine absolute receiver sensitivity.

Receiver stress test
For this application the R&S CMU300 provides different transmitter levels for the active timeslot and for the unused timeslots (dummy bursts). The receiver in the BTS can thus be subjected to unfavourable conditions in the unused timeslots.

Pseudo-random bit streams
The tester uses a choice of four true pseudo-random bit sequences for BER measurement. You will especially appreciate this feature if you have ever overlooked a faulty channel coder by using a fixed bit pattern, because a pseudo-random sequence is the only reliable means of detecting it. For transmitter measurements the BTS RF loop can also be kept closed outside BER measurements. This is a simple way of providing the transmitter signal modulated with pseudo-random bits required for spectrum and power measurements.



BER test environment

RAW BER test

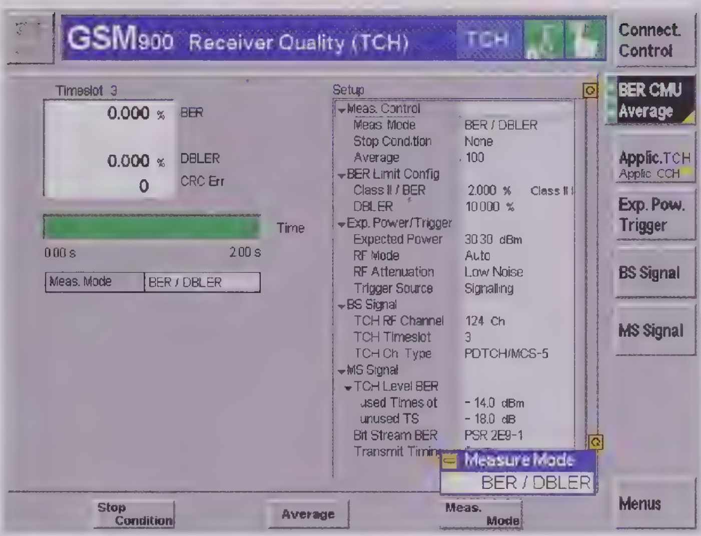
In the burst by burst mode, the R&S CMU300 transmits only bits without error protection such as class II bits. The loop in the BTS under test has to be closed before channel decoding/coding, so raw bits are measured and the BER is evaluated on a burst by burst basis.

BER test of TCHs

Circuit-switched traffic channels can be tested in the BER or residual BER (RBER)/frame erasure rate (FER) test modes. The instrument supports the RF loop and the A_{bis} loop (option R&S CMU-B71 required). A cyclic redundancy check (CRC) excludes bit errors on the return path (downlink) from the BTS to the R&S CMU300. Additionally, the instrument itself can be used as a loop on the U_m air interface, which means that it can loop back information from the RF downlink to the uplink including decoding/coding. The BER result indicates errors of class Ib/II bits. In the RBER/FER mode, the errors of class Ib/II bits of non-erroneous frames are calculated and furthermore, frames with erroneous class Ia bits are taken into account (FER).

BER test of PDTCHs

For packet-switched data traffic channels the bit error ratio test is modified in such a way that the BTS loops back the received data packets on a block by block basis (loop behind channel decoder required) and measures the BER and the data block error rate (DBLER). The test setup is similar to the one which is used on circuit-switched channels. The test is based on an RF connection, where one timeslot is permanently used on the uplink and downlink with packet-switched channel coding being active. No attach/detach functionality is required because no RLC/MAC layer is involved.



```
Timeslot 3
   0.000 %  BER
   0.000 %  DBLER
       0    CRC Err
Meas. Mode  BER / DBLER

Setup
Meas. Control
  Meas Mode          BER / DBLER
  Stop Condition     None
  Average            100
BER Limit Config
  Class II / BER     2.000 %    Class II
  DBLER              10.000 %
Exp. Power/Trigger
  Expected Power     30.30 dBm
  RF Mode            Auto
  RF Attenuation     Low Noise
  Trigger Source     Signalling
BS Signal
  TCH RF Channel     124 Ch
  TCH Timeslot       3
  TCH Ch Type        PDTCH/MCS-5
MS Signal
  TCH Level BER
    used Timeslot    - 14.0 dBm
    unused TS        - 18.0 dB
  Bit Stream BER     PSR 2E9-1
  Transmit Timing
```

Receiver Quality (TCH) menu; RF loop; BER/DBLER mode

Overview of the R&S CMU300 BER test capabilities

Channel type	Possible tests	Supported BTS/BSC loops	Supported loops "inside" R&S CMU (R&SCMU300 as RF loop)	Channel setup procedure	Required options (in addition to R&S CMU-B21)	Comments
–	Burst by burst (RAW BER)	BTS loop demodulator/modulator	R&S CMU RAW BER loop	Forced channel setup without signalling	R&S CMU-K30 to -K34 (R&S CMU-K41 optional for 8PSK)	GMSK and 8PSK supported
TCH/FS **TCH/HS** **TCH/EFS**	BER / RBER / FER	BTS (BSC) BER loop with channel decoding; (optional loop via A_{bis})	R&S CMU BER loop with channel decoding	Forced channel setup without call procedure (optional, MOC/MTC)	R&S CMU-K30 to -K34; (R&S CMU-B71 and R&S CMU-K39 optional)	–
TCH/F14.4 **TCH/9.6** **TCH/F4.8** **TCH/H4.8** **TCH/H2.4**	BER	BTS (BSC) BER loop with channel decoding	R&S CMU BER loop with channel decoding	Forced channel setup without call procedure (optional MOC/MTC for full rate channels)	R&S CMU-K30 to -K34 (R&S CMU-K39 optional)	–
E-TCH/ F43.2 NT	BER	BTS (BSC) BER loop with channel decoding	R&S CMU BER loop with channel decoding	Forced channel setup without signalling	R&S CMU-K30 to -K34 and R&S CMU-K41	–
PDTCH-CS1 **PDTCH-CS2** **PDTCH-CS3** **PDTCH-CS4**	BER/ DBLER	BTS BER loop with channel decoding, without RLC MAC	R&S CMU BER/DBLER loop with channel decoding	Forced channel setup without signalling (one static TS active on up-/down-link)	R&S CMU-K30 to -K34	Special BTS test mode required
PDTCH-MCS1 **PDTCH-MCS2** **PDTCH-MCS3** **PDTCH-MCS4** **PDTCH-MCS5** **PDTCH-MCS6** **PDTCH-MCS7** **PDTCH-MCS8** **PDTCH-MCS9**	BER/ DBLER	BTS BER loop with channel decoding, without RLC MAC	R&S CMU BER/DBLER loop with channel decoding	Forced channel setup without signalling (one static TS active on up-/down-link)	R&S CMU-K30 to -K34 and R&S CMU-K41	Special BTS test mode required

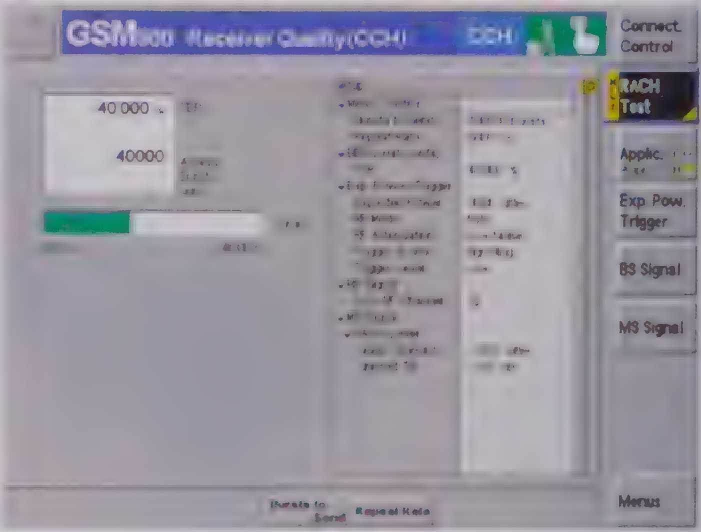
Additional functions for GSM/EDGE conformance tests

RACH test

The R&S CMU300 transmits a sequence of random access bursts on the random access channel (RACH) to the base station and analyzes the frame erasure rate (FER) of the immediate assignments that are returned by the base station controller (BSC). The number of bursts to be transmitted and the intervals between them can be varied. The test setup of the RACH test must reflect the conditions of the real network, i.e. the base transceiver station (BTS) must be controlled by the BSC or the BSC simulator.

Applications

- Network stress tests for checking the maximum registration capacity
- Sensitivity measurements with reference to the RACH are thus possible


GSM900 Receiver Quality(CCH)
CCH
40 000
40000
Connect. Control
RACH Test
Applic.
Exp. Pow. Trigger
BS Signal
MS Signal
Menus
Bursts to Send
Repeat Rate

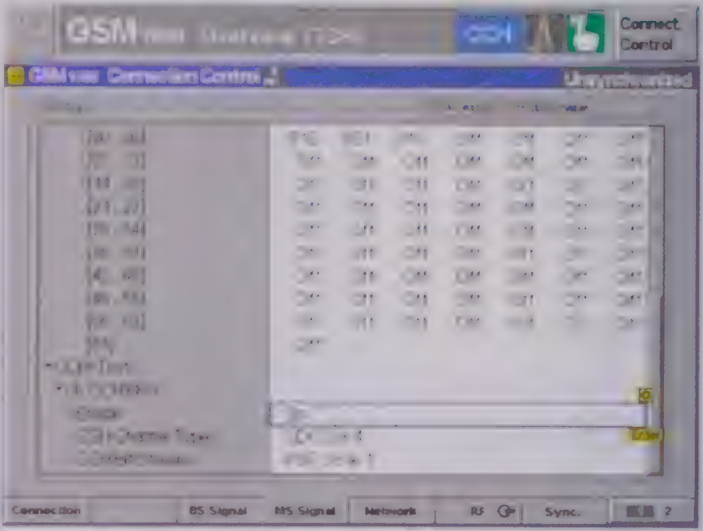
The FER is the ratio of the number of sent RACH bursts to the immediate assignments received

Test of signalling channels

For conformance tests, the R&S CMU300 provides the following uplink signalling channels modulated with PSR data (option R&S CMU-K38)

- FACCH/F
- SACCH
- SDCCH/4
- SDCCH/8

The PSR data must be evaluated in the BTS or its controller.


GSM
CCH
Connect. Control
GSM900 Connection Control
Connection
BS Signal
MS Signal
Network
RF
Sync.
2

The uplink signalling channels can be activated via the GSM connection control menu

Test of base stations in the slow frequency hopping mode

If a base station supports the hopping mode, it must be tested in accordance with the 3GPP TS 51.021 base station specifications under hopping conditions. It must therefore be possible to set the instruments to the hopping mode. The R&S CMU300 provides the following options:

Activation by call

The tester synchronizes to the BCCH. The channel to be tested is activated via the standard MOC/MTC call procedures. The base station transmits the following parameters required for hopping:

- Mobile allocation index offset (MAIO)
- Hopping sequence list

On the basis of the current frame number, the R&S CMU300 starts hopping in accordance with the ETSI specifications.

Forced hopping

In contrast to the above, the parameters are manually entered directly into the tester. The traffic channel must be activated without a signalling procedure. The previously synchronized R&S CMU300 then starts hopping on the basis of the current frame number in accordance with ETSI specification TS 05.02.

GSM TX measurements

GMSK

Phase and frequency error

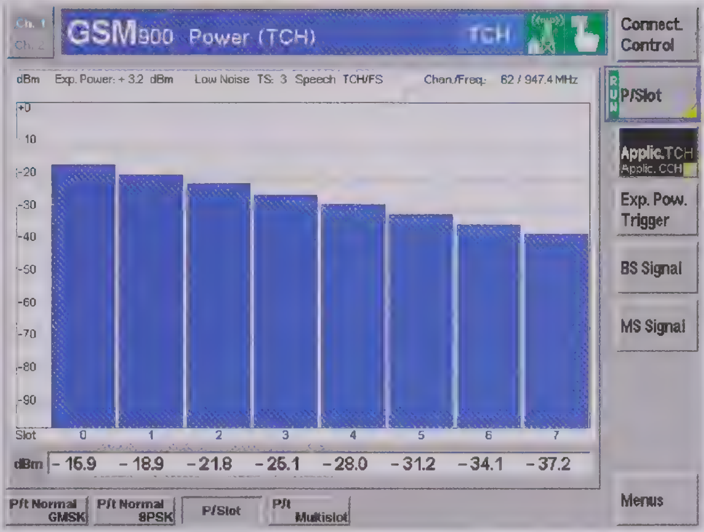
The actual phase of the signal received from the base station is recorded during the entire burst and stored. The transferred data is demodulated and the training sequence searched for. The middle of the training sequence (transition between bits 13 and 14) is used for time synchronization.

The complete data content of the burst is then mathematically modulated using an ideal modulator. The resulting ideal phase is compared with the measured phase. From the difference between the two quantities (the phase difference trajectory), a regression line is calculated using the mean square error method. The phase error is the difference between the phase difference trajectory and the regression line; it is calculated and plotted over the whole useful part of the burst. The average frequency error in the burst is equal to the derivative of the regression line with respect to time.

The R&S CMU 300 evaluates the phase error with a resolution of 4 measured values per modulated bit, which corresponds to a sampling rate of approx. 1 MHz.

Spectrum measurements

The spectrum measurement determines the amount of energy that spills out of the designated radio channel when the base station transmits with predefined output power. The measurement is performed in the time domain mode, at a number of frequency points symmetrically distributed around the nominal frequency of the designated channel.



GSM900 Power (TCH)

dBm Exp. Power: + 3.2 dBm Low Noise TS: 3 Speech TCH/FS Chan./Freq.: 62 / 947.4 MHz

Slot	0	1	2	3	4	5	6	7
dBm	- 16.9	- 18.9	- 21.8	- 25.1	- 28.0	- 31.2	- 34.1	- 37.2

The power versus slot measurement simultaneously provides information about 8 power steps

Power measurements

The signal power received from the base station is displayed as a function of time (burst analysis) over one burst period. The measurement graph can be further processed to determine an average, minimum or maximum result as well as to calculate the average over the whole burst. In addition to the burst power measurement, a limit check with tolerances is performed. The displayed continuous measurement is derived from 668 equidistant measurement points with a ¼ bit spacing, covering a time range of 156 ¾ bit.

In the signalling mode only, a second application is available – the power versus slot measurement. The power versus slot measurement determines the average burst power in all eight timeslots of a TDMA frame. The average is taken over a section of the useful part of the burst; it is not correlated to the training sequence. The result is displayed as eight bar graphs, one for each time slot of a single frame, which allows a very large number of bursts to be measured in extremely short time. Therefore this application is suitable whenever the behaviour or the stability of the average burst power in consecutive timeslots is to be monitored. Another highlight of this measurement is the fact that power results are available almost in realtime. The power versus time measurement, however, returns the current, average, maximum and minimum value within a statistic cycle.

EDGE TX measurements

8PSK

8PSK/EDGE is another step towards increasing the mobile radio data rate. By using the available GSM frame structure, the gross data rate is three times that obtained with GMSK. The R&S CMU300 can already perform 8PSK on GSM bursts and analyze them owing to advanced measurement applications. Error vector magnitude and magnitude error have been added to the range of modulation measurements. New templates for power versus time measurements ensure compliance with the specifications, as do the modified tolerances for spectrum measurements. As with all measurements provided by the R&S CMU300, special attention has been given to achieving maximum measurement accuracy and speed for EDGE too. All measurement tolerances are set by default to GSM recommendation 11.21 but may of course be altered to suit individual needs.

Modulation analysis

For modulation analysis, the actual modulation vector of the signal received from the base station is measured over the complete burst and stored. The following non-redundant quantities are calculated on the basis of a comparison of this vector with the computed ideal signal vector.

- Phase error
  The phase error is the difference between the phases of measured and the ideal signal vector.
- Magnitude error
  The magnitude error is the difference between the magnitudes of the measured and the ideal signal vector.
- Error vector magnitude (EVM)
  The EVM is the magnitude of the vector connecting the measured and the ideal signal vector. In contrast to the previous quantities, the EVM cannot be negative.

These three quantities are calculated as a function of time and displayed over the whole useful part of the burst (symbols 6 to 162), each of them in a separate graphical measurement menu. In addition, the peak and RMS values of all three quantities are calculated (over the whole display range or over the first ten symbols only) and displayed.

Finally, the modulation analysis provides the following scalar quantities:

- 95 th percentile
  Limit value below which 95% of the values of a measurement graph are located. The 95 th percentile of a measured quantity has the same unit as the quantity itself. The R&S CMU300 determines 95 th percentiles for EVM, magnitude error and phase error.
- Origin offset
  The origin offset in the I/Q constellation diagram reflects a DC offset in the baseband signal. The origin offset corresponds to an RF carrier feedthrough.
- I/Q imbalance
  Amplitude difference between the inphase (I) and the quadrature (Q) components of the measured signal, normalized and logarithmic. The I/ Q imbalance corresponds to an unwanted signal in the opposite sideband.
- Frequency error
  Difference between the measured frequency and the expected frequency. For the tolerance check all three phase error graphs can be fitted into a tolerance template and checked.

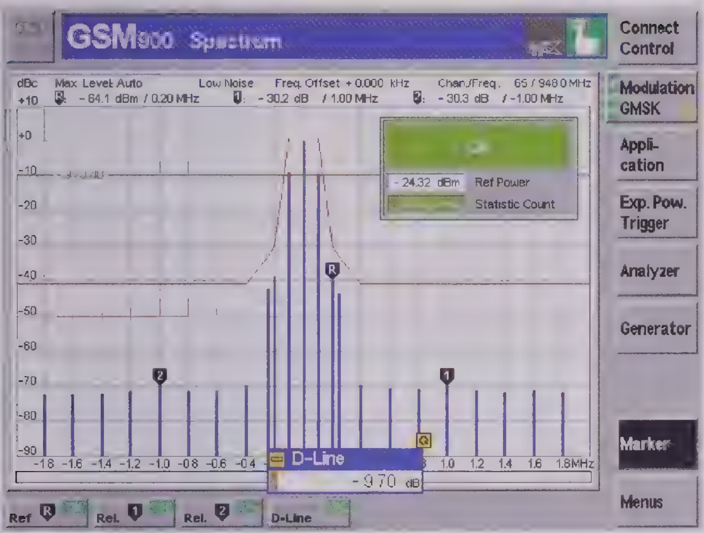
Power measurements

The 8 PSK power versus time measurement results are similar to the GMSK measurement results. With 8PSK modulation the time axis is scaled in symbol points. 8PSK symbols and GMSK bits have the same transmission rate.

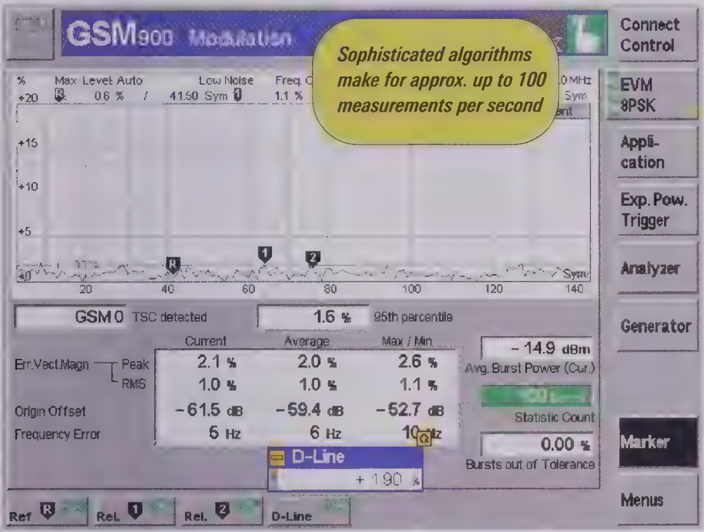
Owing to the characteristics of 8PSK modulation, the amplitude of the RF signal varies according to the data transmitted.

The average setting ensures that a correct reference power is used, the results being averaged, however, over an extended measurement time. In data-compensated mode, a known data sequence is used to correct the measured average power of the current burst and estimate the correct reference power.

The R&S CMU300 can be used to check the power ramps of up to 4 successive bursts for multislot applications. Measurements are performed in the signalling measurement mode and can automatically adapt the power ramp required in each burst to the type of modulation used (GMSK or 8PSK). This feature makes the instrument ideal for use in testing transmitters that must support both types of modulation.

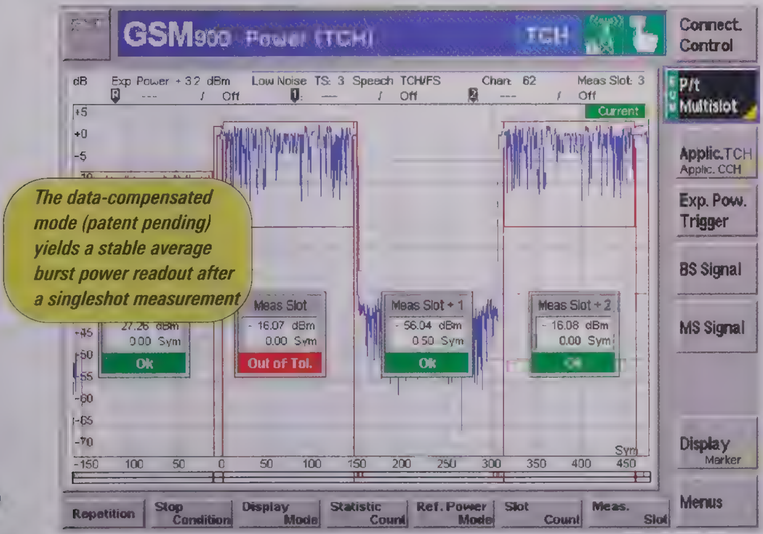

GSM900 Spectrum
Connect Control
Modulation GMSK
Application
Exp. Pow. Trigger
Analyzer
Generator
Marker
Menus
Max. Level: Auto
Low Noise
Freq. Offset + 0.000 kHz
Chan./Freq. 65 / 948.0 MHz
- 64.1 dBm / 0.20 MHz
- 30.2 dB / 1.00 MHz
- 30.3 dB / -1.00 MHz
- 24.32 dBm Ref Power
Statistic Count
D-Line
- 9.70 dB
Ref
Rel.
Rel.
D-Line

Different graphical functions (marker, limit line) are available for spectrum due to modulation measurement


GSM900 Modulation
Connect Control
EVM 8PSK
Application
Exp. Pow. Trigger
Analyzer
Generator
Marker
Menus
Max. Level: Auto
Low Noise
GSM 0 TSC detected
1.6 % 95th percentile
Current
Average
Max / Min
Err.Vect.Magn
Peak
RMS
Origin Offset
Frequency Error
2.1 %
2.0 %
2.6 %
1.0 %
1.0 %
1.1 %
-61.5 dB
-59.4 dB
-52.7 dB
5 Hz
6 Hz
10 Hz
- 14.9 dBm
Avg. Burst Power (Cur.)
Statistic Count
0.00 %
Bursts out of Tolerance
D-Line
+ 1.90 %
Ref
Rel.
Rel.
D-Line

Sophisticated algorithms make for approx. up to 100 measurements per second

The Modulation Overview 8PSK menu selects all scalar modulation results to be displayed


GSM900 Power (TCH)
TCH
Connect. Control
P/t Multislot
Applic. TCH
Applic. CCH
Exp. Pow. Trigger
BS Signal
MS Signal
Display Marker
Menus
Exp. Power + 32 dBm
Low Noise
TS: 3
Speech: TCH/FS
Chan: 62
Meas Slot: 3
Current
27.26 dBm
0.00 Sym
Ok
Meas Slot
- 16.07 dBm
0.00 Sym
Out of Tol.
Meas Slot + 1
- 56.04 dBm
0.50 Sym
Ok
Meas Slot + 2
- 16.08 dBm
0.00 Sym
Ok
Repetition
Stop Condition
Display Mode
Statistic Count
Ref. Power Mode
Slot Count
Meas. Slot

The data-compensated mode (patent pending) yields a stable average burst power readout after a singleshot measurement

The power-versus-time multislot application can graphically display up to 4 adjacent timeslots, automatically detects GMSK- and 8PSK-modulated signals and activates the associated templates in realtime. A new zoom function allows full-screen display on each slot.

GSM/EDGE highlights of the R&S CMU300

Synchronization to BTS

- Via BTS multiframe trigger
- Via RF synchronization procedure to CCH

Activation of channel to be measured

- Without call procedure
- Simulation of mobile station including location update and MOC/MTC call procedures

GMSK/8PSK measurements

- Phase/frequency error (GMSK)
- EVM including magnitude error, origin offset, I/Q imbalance (8PSK)
- Power versus time
- Power versus slot (GMSK)
- Peak power/average burst power
- General spectrum measurements
- RAW BER, BER, RBER/FER measurements on circuit-switched channels
- BER/DBLER measurements on packet-switched channels

More features

- Realtime channel coding/decoding
- Timeslot-selective measurements in signalling mode
- Flexible RF interface for easy adaptation to DUT
- Hopping on packet-switched channels (PDTCH) supported
- RACH test
- Additional features for conformance testing
- Generation of UL signalling channels

Support of different BER test environments/loops

- BTS loop without channel coding
- BTS loop with channel coding
- Loop via A_{bis} interface
- R&S CMU 300 as RF loop with channel coding

3GPP FDD RX measurements

RF generator for Node B receiver tests

The options R&S CMU-B76 und R&S CMU-K76 add WCDMA generator functionality to the R&S CMU300, thus making it ideal not only for receiver measurements on GSM/EDGE base stations, but also for unprecedented receiver measurements on WCDMA base stations.

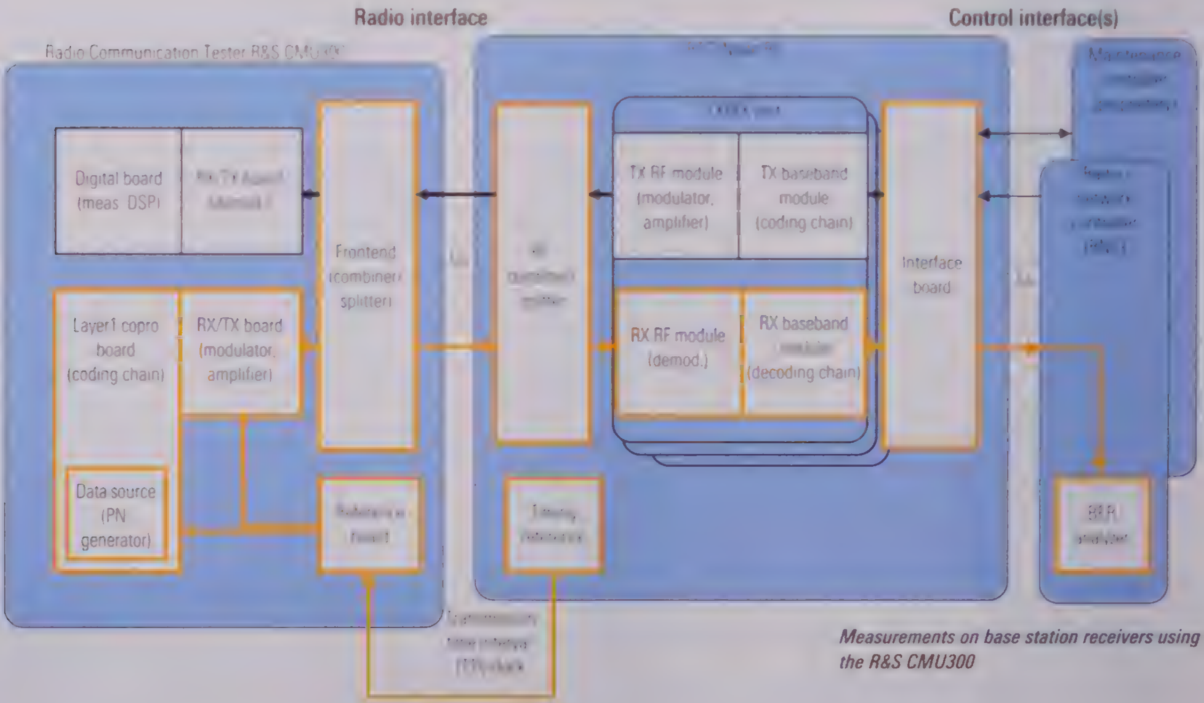
The R&S CMU300 supports all reference measurement channels (RMC) defined in the 3GPP specification TS25 141 (FDD) up to a data rate of 2 Mbit/s.

Sensitivity measurements on base station receivers
WCDMA generators are used to test receivers in base stations (Node B) as well as their modules. The bit error rate (BER) of the signal generated by the R&S CMU300 can be measured in the base station, in the connected radio network controller (RNC) or via an external analyzer.

For BER measurements, the analyzer must be synchronized to the received signals. Particularly for reference measurement channels, the transmitter must emit them in a defined format at a specific transmission time interval (TTI) at the physical layer. For this purpose, the R&S CMU300 provides the frame trigger input. After the WCDMA generator has been started, the requested channel is transmitted once the frame trigger (10/20/40/80 ms) has been received.

The base station receiver synchronizes to the RF signal of the R&S CMU300 and then calculates the BER from the deviation of the received signal from the expected PRBS. In 3GPP base station production, the BER can be measured without connection setup, thus keeping loss of time to a minimum.

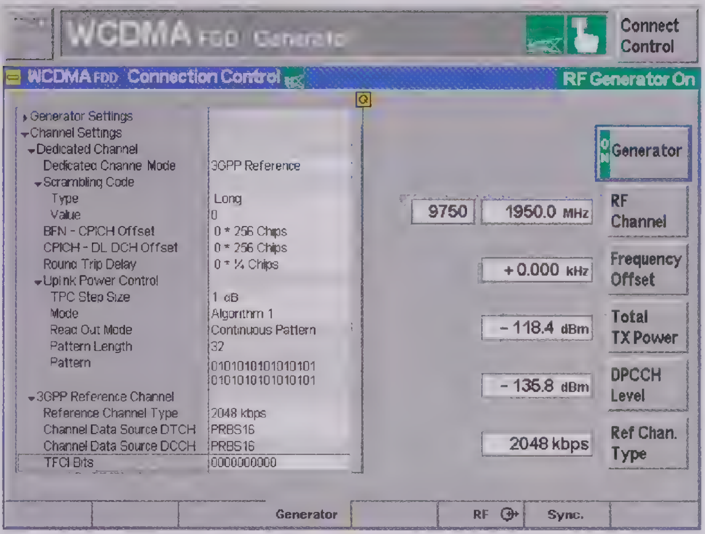
Functions and operating modes
The generator parameters defined in the 3GPP specification TS25 141 (FDD) ensure standardized measurements. The WCDMA generator of the R&S CMU300 supports all data rates defined for the reference measurement channels, i.e. 12.2 / 64 / 144 / 384 / 2048 kbit/s. If one of these RMCs is selected, essential parameters for BER measurement such as coding, slot format or time transmission interval are defined. Moreover, the user can also set customized channel combinations. In addition to the RMC mode, the WCDMA generator supports the physical channel mode. In this case, the generator creates one dedicated physical control channel (DPCCH) and up to six data channels (DPDCH). The associated data rates can be flexibly selected in the range 1×15 kbit/s to 6×960 kbit/s. The test data is applied at the transport channel layer either to the reference measurement channels or directly to the physical channels. Pseudo-random bit sequences PRBS 9 / 11 / 15 and 16 as well as fixed data (00000…, 11111…, 010101…) are available as test data. The signal power in particular can be set in almost any manner designed for BER measurements. The user is able to set the total power as well as the power of the control channel and


Radio interface
Control interface(s)
Radio Communication Tester R&S CMU300
Digital board (meas. DSP)
Frontend (combiner/splitter)
Layer1 copro board (coding chain)
RX/TX board (modulator, amplifier)
Data source (PN generator)
TX RF module (modulator, amplifier)
TX baseband module (coding chain)
RX RF module (demod.)
RX baseband (decoding chain)
Interface board
Maintenance

Measurements on base station receivers using the R&S CMU300 the power ratio of the DPCCH and the DPDCH. The R&S CMU300 offers a wide variety of further settings which by far exceed the RMCs defined by 3GPP. At the physical layer, the TFCI code word and the TPC bit pattern can be varied. If channel coding has been activated, the generator calculates the TFCI code word with the associated TFCI bits. These settings allow the control of a base station receiver via the uplink signal.

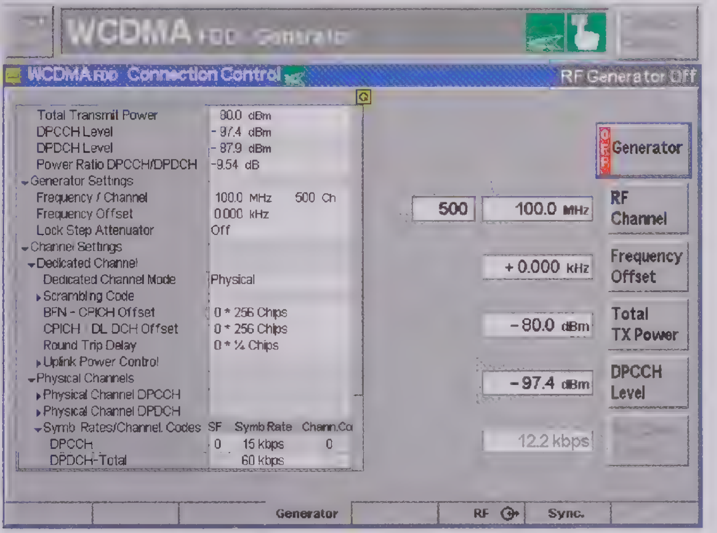
The base station receiver receives the TPC bits and controls the power according to the selected downlink power control mode.

At the transmitter end, the R&S CMU300 supports power control modes 1 and 2. In mode 1, the transmit power of the generator changes in every alternating slot, increasing or decreasing by 1 dB or 2 dB. In mode 2, transmit power is constant.


WCDMA FDD Generator
Connect Control
WCDMA FDD Connection Control
RF Generator On
Generator
9750
1950.0 MHz
RF Channel
+ 0.000 kHz
Frequency Offset
- 118.4 dBm
Total TX Power
- 135.8 dBm
DPCCH Level
2048 kbps
Ref Chan. Type
Generator
RF
Sync.

Generator Settings	
Channel Settings	
Dedicated Channel	
Dedicated Channel Mode	3GPP Reference
Scrambling Code	
Type	Long
Value	0
BFN - CPICH Offset	0 * 256 Chips
CPICH - DL DCH Offset	0 * 256 Chips
Round Trip Delay	0 * ¼ Chips
Uplink Power Control	
TPC Step Size	1 dB
Mode	Algorithm 1
Read Out Mode	Continuous Pattern
Pattern Length	32
Pattern	0101010101010101 0101010101010101
3GPP Reference Channel	
Reference Channel Type	2048 kbps
Channel Data Source DTCH	PRBS16
Channel Data Source DCCH	PRBS16
TFCI Bits	0000000000

Generator menu of the R&S CMU300 in the reference channel mode with selected 2 Mbit/s channel


WCDMA FDD Generator
WCDMA FDD Connection Control
RF Generator Off
Generator
500
100.0 MHz
RF Channel
+ 0.000 kHz
Frequency Offset
- 80.0 dBm
Total TX Power
- 97.4 dBm
DPCCH Level
12.2 kbps
Generator
RF
Sync.

Total Transmit Power	80.0 dBm		
DPCCH Level	- 97.4 dBm		
DPDCH Level	- 87.9 dBm		
Power Ratio DPCCH/DPDCH	-9.54 dB		
Generator Settings			
Frequency / Channel	100.0 MHz	500 Ch	
Frequency Offset	0.000 kHz		
Lock Step Attenuator	Off		
Channel Settings			
Dedicated Channel			
Dedicated Channel Mode	Physical		
Scrambling Code			
BFN - CPICH Offset	0 * 256 Chips		
CPICH DL DCH Offset	0 * 256 Chips		
Round Trip Delay	0 * ¼ Chips		
Uplink Power Control			
Physical Channels			
Physical Channel DPCCH			
Physical Channel DPDCH			
Symb Rates/Channel Codes	SF	Symb Rate	Chann.Co
DPCCH	0	15 kbps	0
DPDCH-Total		60 kbps	

Generator setup menu of the R&S CMU300 with set physical channel mode

3GPP FDD TX measurements

Node B transmitter measurements

By means of the options R&S CMU-U75 and R&S CMU-K75, the R&S CMU300 is able to test the main transmission parameters of WCDMA base stations (Node Bs). The test models used are based on the 3GPP test specification TS25 141 FDD. However, the instrument is not limited to the test model specified for a given measurement, i.e. any test model can be selected for any measurement. For example, channel model 1 64, which contains 64 active dedicated channels (DCH), can be used for modulation measurements, although it was primarily designed for spectrum measurements. The time-consuming reconfiguration of the BTS can be omitted with some applications because all parameters can be measured with the same test model.

Code domain power (CDP)
Precise power control in uplink and downlink is essential in CDMA systems. The CDP measurement analyzes power distribution across the individual code channels by recording and measuring a complete WCDMA frame for each measurement cycle. The screen is divided into three sections to handle the complex signal structure.

In the top section, the CDP is displayed as a function of all codes. Active code channels are colour-highlighted and combined to form a bar whose width depends on the spreading factor.

In the center section, the CDP of a selected code is displayed as a function of time. Since the individual code channels may be time-delayed with respect to the frame start, the center diagram contains two time scales. The common pilot channel (CPICH) is used as a reference for the different measurement results because it is not time-delayed (displayed on the first scale). A second scale refers to the selected code channel.

In the lower section, the CDP and other measurands are displayed as scalar values referring to the selected CPICH slot. This yields an overview of the behaviour of important parameters. Toggling between the individual test menus is thus not necessary.

Code domain error power (CDEP)
The CDEP is an analysis of the error signal in the code domain, i.e. the projection of the error power onto the individual code channels. As with the CDP measurement, the screen is divided into three sections. The CDEP is to be measured across a CPICH slot with a defined spreading factor.

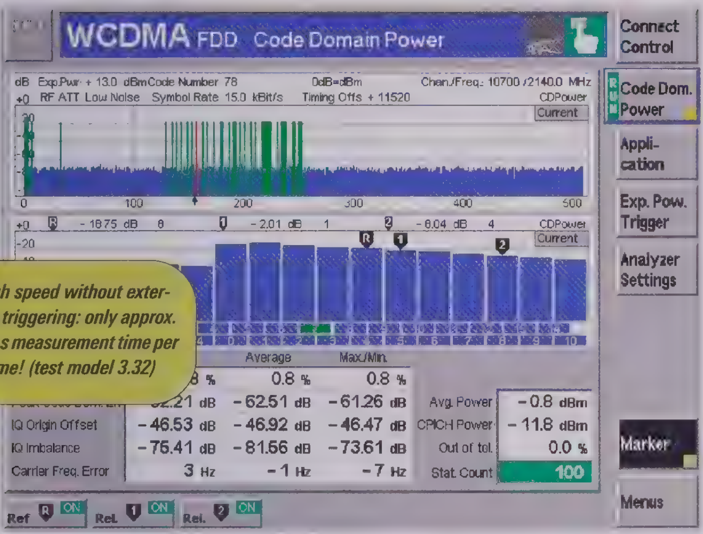
The top diagram displays the CDEP as a function of all codes in the selected CPICH slot. In the center diagram, the peak code domain error power (PCDEP) is displayed as a function of all 15 frame slots. Here, too, comprehensive means for analysis are available. For example, if there is a particularly high PCDEP in a slot, the CDEP as a function of all codes can be viewed by selecting this slot, and thus the code channel with the maximum error can be detected.

Error vector magnitude (EVM)
In the time domain, the EVM is equivalent to the CDEP in the code domain. The EVM is the difference between the ideal reference signal and the processed test signal. In contrast to the CDEP, the error is analyzed at the chip level, so that errors are shown as a function of time on the basis of the chip offset from the selected CPICH slot. Analysis is again frame-based; therefore all RMS values of the individual slots are also displayed as a function of time.

Occupied bandwidth (OBW), spectrum emmision mask (SEM) and adjacent channel leakage ratio (ACLR)

OBW, SEM and ACLR are important additional measurements for the spectral analysis of a WCDMA transmitter. The R&S CMU300 conveniently provides them as "single key" measurements.

Multicarrier operation
Today's base stations are increasingly implementing multicarrier operation. The R&S CMU300 can perform measurements in real multicarrier environments; up to four carriers running simultaneously on a base station will have minimal effects on the measurement results.


WCDMA FDD Code Domain Power
Connect Control
Code Dom. Power
Appli-cation
Exp. Pow. Trigger
Analyzer Settings
Marker
Menus
Current
CDPower
0
100
200
300
400
500
-20
Ref ON
Rel. ON
Rel. ON

dB Exp.Pwr: + 13.0 dBm Code Number 78 0dB=dBm Chan./Freq.: 10700 / 2140.0 MHz
+0 RF ATT Low Noise Symbol Rate 15.0 kBit/s Timing Offs + 11520

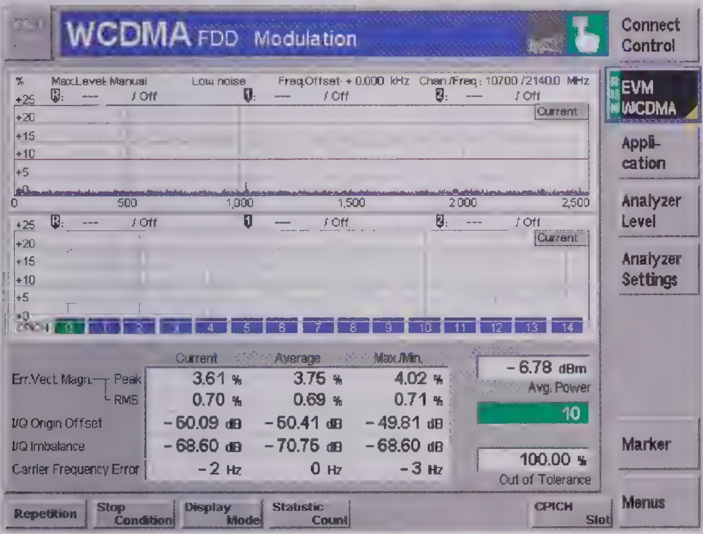
+0 R - 18.75 dB 8 1 - 2.01 dB 1 2 - 8.04 dB 4

	Average	Max./Min.
8 %	0.8 %	0.8 %
2.21 dB	- 62.51 dB	- 61.26 dB
IQ Origin Offset - 46.53 dB	- 46.92 dB	- 46.47 dB
IQ Imbalance - 75.41 dB	- 81.56 dB	- 73.61 dB
Carrier Freq. Error 3 Hz	- 1 Hz	- 7 Hz

Avg. Power - 0.8 dBm
CPICH Power - 11.8 dBm
Out of tol. 0.0 %
Stat. Count 100

High speed without external triggering: only approx. 0.3 s measurement time per frame! (test model 3.32)

Code domain power measurement with test model 3.32

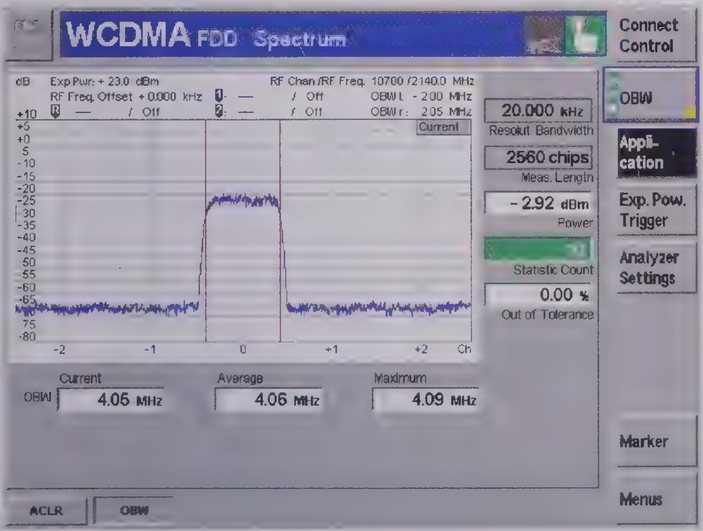

WCDMA FDD Modulation
Connect Control
EVM WCDMA
Appli-cation
Analyzer Level
Analyzer Settings
Marker
Menus
Current
+25
+20
+15
+10
+5
+0
0
500
1,000
1,500
2 000
2,500
CPICH
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Repetition
Stop Condition
Display Mode
Statistic Count
CPICH Slot

% Max.Level: Manual Low noise Freq.Offset: + 0.000 kHz Chan./Freq.: 10700 / 2140.0 MHz
R: --- / Off 1: --- / Off 2: --- / Off

		Current	Average	Max./Min.
Err.Vect. Magn.	Peak	3.61 %	3.75 %	4.02 %
	RMS	0.70 %	0.69 %	0.71 %
I/Q Origin Offset		- 50.09 dB	- 50.41 dB	- 49.81 dB
I/Q Imbalance		- 68.60 dB	- 70.76 dB	- 68.60 dB
Carrier Frequency Error		- 2 Hz	0 Hz	- 3 Hz

- 6.78 dBm Avg. Power
10
100.00 % Out of Tolerance

Error vector magnitude measurement


WCDMA FDD Spectrum
Connect Control
OBW
Appli-cation
Exp. Pow. Trigger
Analyzer Settings
Marker
Menus
Current
+10
+5
+0
5
-10
-15
-20
-25
-30
-35
-40
-45
50
55
-60
-65
75
-80
-2
-1
0
+1
+2
Ch
ACLR
OBW

dB Exp.Pwr: + 23.0 dBm RF Chan./RF Freq. 10700 / 2140.0 MHz
RF Freq. Offset + 0.000 kHz 1: — / Off OBW l: - 2.00 MHz
R — / Off 2: — / Off OBW r: 2.05 MHz

20.000 kHz Resolut. Bandwidth
2560 chips Meas. Length
- 2.92 dBm Power
Statistic Count
0.00 % Out of Tolerance

	Current	Average	Maximum
OBW	4.05 MHz	4.06 MHz	4.09 MHz

Occupied bandwidth measurement

Innovative R&S CMU300:

- Compact radio test set featuring GSM/GPRS/EDGE and WCDMA standards in one unit
- Existing GSM/EDGE instruments easily upgradeable to WCDMA
- Clear and easy-to-operate user interface

WCDMA receiver tests

- Provision of all uplink reference channels from 12.2 kbps to 2048 kbps
- Signal generation in realtime with test data lengths up to PRBS 16 for continuous receiver measurements
- Extremely fast response to newly entered parameters if the RF signal is active

WCDMA transmitter measurements

- Comprehensive high-speed power, modulation and spectrum measurements

I/Q and IF interfaces for the R&S CMU300

Functionality

The option R&S CMU-B17 allows access to analog I/Q and IF signals in both communication directions (uplink and downlink). Once a radio link has been established, complex I/Q signals can be applied or transmitted for further analysis. This solution will allow the R&S CMU 300 to be used for new tasks in the development and testing of base stations and their modules.

Technical concept

The selectable I/Q and IF interface module is looped between the RF module (modulator, demodulator) and the digital module (test DSP, signalling unit) of the R&S CMU 300. During normal operation without access to I/Q or IF signals, the interface module can be set to the bypass mode. This eliminates any further influence on the transmit and receive signal, and the original data of the instrument is retained. In addition to preconfigured default settings for constantly recurring T&M tasks (e.g. fading of the transmit signal), all types of customized signal path combinations can be set.

Receiver tests under fading conditions

A fading simulator is used to test the receiver characteristics of base stations under practical conditions. An RF channel that is ideal if the tester and the DUT are connected by means of a cable is provided with fading effects that also occur under real field conditions.

Fitted with the option R&S CMU-B17, the R&S CMU 300, together with the Fading Simulator R&S ABFS, provides a cost-effective solution for the specified measurement task. Optionally, the Signal Generator R&S SMIQ with the option R&S SMIQB14 can be used; the transmit module of the generator can also provide a faded RF signal.

Testing of mobile radio modules

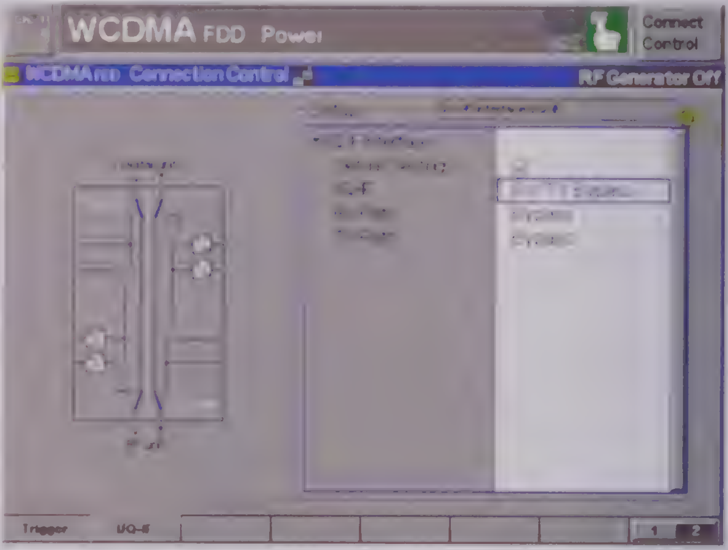
Another major application is the generation and analysis of I/Q signals. Most mobile radio modules include an RF module and a baseband module that communicate with each other via an analog I/Q interface. The I/Q and IF interface can now be used to access the RF modules from both sides.

Quite often, different teams in the development departments are responsible for the RF and the baseband modules. Testing via the I/Q interfaces allows space- and time-independent development work.

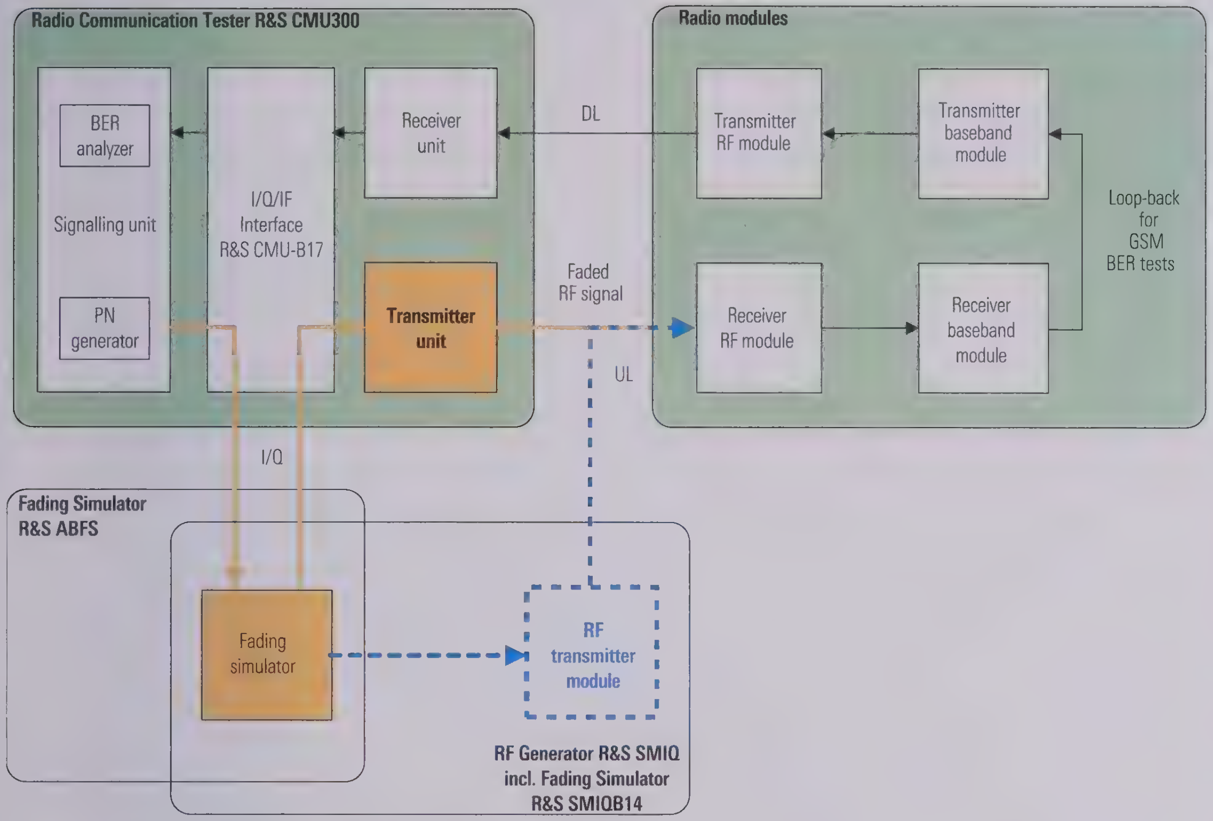
I/Q signal analysis

If I/Q signals are applied to the receive path of the R&S CMU 300, they can be analyzed analogously to the RF signals. In addition to more complex modulation parameters (error vector magnitude (EVM), peak code domain error power), direct I/Q parameters such as I/Q offset or I/Q imbalance can be analyzed.

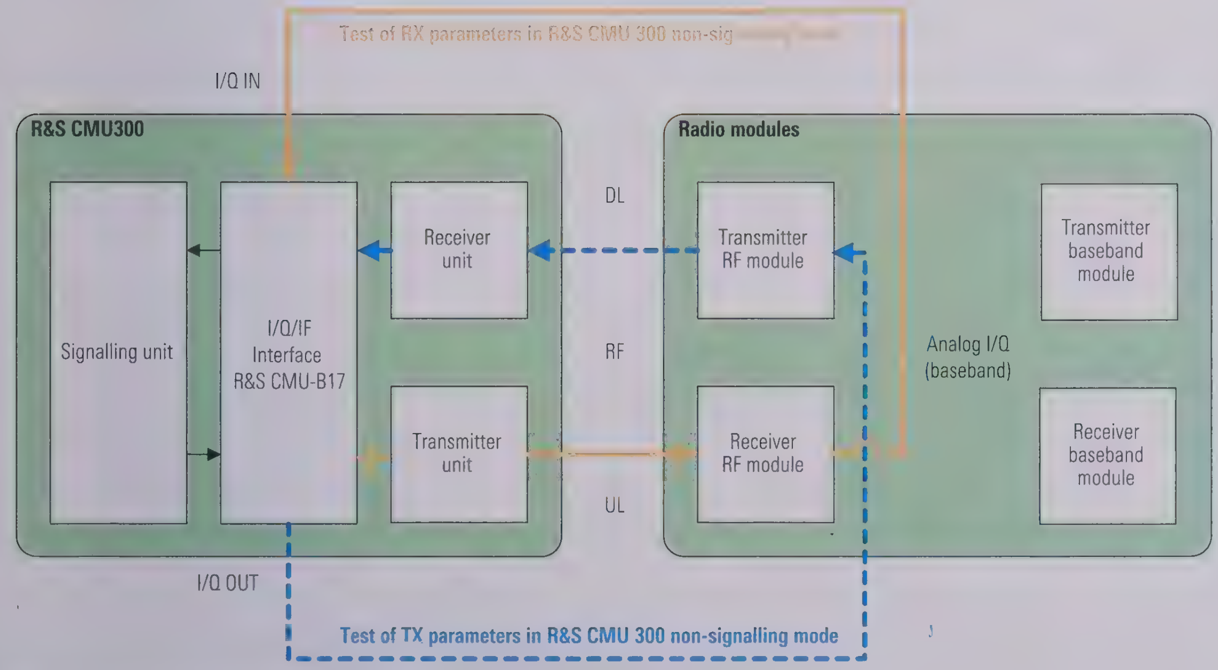
Your local Rohde & Schwarz representative will gladly provide you with further information about the option R&S CMU-B17.



Menu in the R&S CMU300 for setting the test paths (default setting: RX/TX bypass mode)


Radio Communication Tester R&S CMU300
BER analyzer
Signalling unit
PN generator
I/Q/IF Interface R&S CMU-B17
Receiver unit
Transmitter unit
DL
Faded RF signal
UL
Radio modules
Transmitter RF module
Transmitter baseband module
Receiver RF module
Receiver baseband module
Loop-back for GSM BER tests
I/Q
Fading Simulator R&S ABFS
Fading simulator
RF transmitter module
RF Generator R&S SMIQ incl. Fading Simulator R&S SMIQB14

Test setup for receiver tests under fading conditions


Test of RX parameters in R&S CMU 300 non-signalling mode
I/Q IN
R&S CMU300
Signalling unit
I/Q/IF Interface R&S CMU-B17
Receiver unit
Transmitter unit
DL
RF
UL
Radio modules
Transmitter RF module
Receiver RF module
Transmitter baseband module
Receiver baseband module
Analog I/Q (baseband)
I/Q OUT
Test of TX parameters in R&S CMU 300 non-signalling mode

Signal paths when testing RF modules

Models and options

Instruments, options and ordering information

Type/Option	Description	BERT GSM	BERT GPRS	BERT EGPRS	GMSK TX tests	8PSK TX tests	FDD UL generator	FDD DL TX test	Order No.
R&S CMU300	Universal Radio Communication Tester for BTS Test	✓	✓	✓	✓	✓	✓	✓	1100.0008.03
R&S CMU-B12	[illegible]	☺	–	☺	–	☺	–	–	1100.5100.02
R&S CMU-B17	[illegible]	☺	–	☺	–	☺	–	–	[illegible]
R&S CMU-B21 Var 02	[illegible]	✓	✓	✓	✓	✓	–	–	[illegible]
R&S CMU-B71	[illegible]	☺	–	–	–	–	–	–	[illegible]
R&S CMU-B76	[illegible]						✓		[illegible]
R&S CMU-K30	[illegible]	✓	✓	✓	✓	✓	–	–	[illegible]
R&S CMU-K31	[illegible]	✓	✓	✓	✓	✓	–	–	[illegible]
R&S CMU-K32	[illegible]	✓	✓	✓	✓	✓	–	–	[illegible]
R&S CMU-K33	[illegible]	✓	✓	✓	✓	✓	–	–	[illegible]
R&S CMU-K34	[illegible]	✓	✓	✓	✓	✓	–	–	[illegible]
R&S CMU-K38	[illegible]	[illegible]	–	–	–	–	–	–	[illegible]
R&S CMU-K39	[illegible]	[illegible]	–	–	[illegible]	[illegible]	–	–	[illegible]
R&S CMU-K41	[illegible]	–	–	✓	–	✓	–	–	[illegible]
R&S CMU-K75	[illegible]	–	–	–	–	–	–	✓	[illegible]
R&S CMU-K76	[illegible]	–	–	–	–	–	✓	–	[illegible]
R&S CMU-U10	[illegible]	☺	☺	☺	☺	☺	☺	☺	[illegible]
R&S CMU-U74	[illegible]	–	–	–	–	–	–	☺	[illegible]
R&S CMU-U75	[illegible]	–	–	–	–	–	–	✓	[illegible]
R&S CMU-U76	[illegible]	–	–	–	–	–	☺	–	[illegible]
R&S CMU-DCV	Documentation of calibration values	☺	☺	☺	☺	☺	☺	☺	[illegible]
R&S CMU-DKD	R&S CMU200/300 DKD calibration incl. ISO9000 calibration (order only with device)	☺	☺	☺	☺	☺	☺	☺	[illegible]
R&S CMU-Z1	Accessory: 256 Mbyte memory card, PCMCIA type 3	☺	☺	☺	☺	☺	☺	☺	[illegible]
R&S CMU-Z6	[illegible]	–	–	–	–	–	–	☺	[illegible]
R&S PSM-B9	[illegible]	☺	☺	☺	☺	☺	☺	☺	[illegible]
R&S ZAA-411	19" rack adapter	☺	☺	☺	☺	☺	☺	☺	1096 3283.00

Comments on table:

✓ mandatory, ☺ optional, – not applicable

¹) Depending on the required frequency band

For specifications please refer to doccument PD 0758.0000.22, version ≥1.00

Certified Quality System
ISO 9001
DQS REG. NO 1954 QM

Certified Environmental System
ISO 14001
DQS REG. NO 1954 UM

ROHDE&SCHWARZ

Rohde&Schwarz GmbH&Co. KG · Mühldorfstraße 15 · 81671 München · Germany · P.O.B. 80 14 69 · 81614 München · Germany · Telephone +49 89 41 29-0
www.rohde-schwarz.com · Customer Support: Telephone +49 1805124242, Fax +49 89 41 29-137 77, E-mail: CustomerSupport@rohde-schwarz.com

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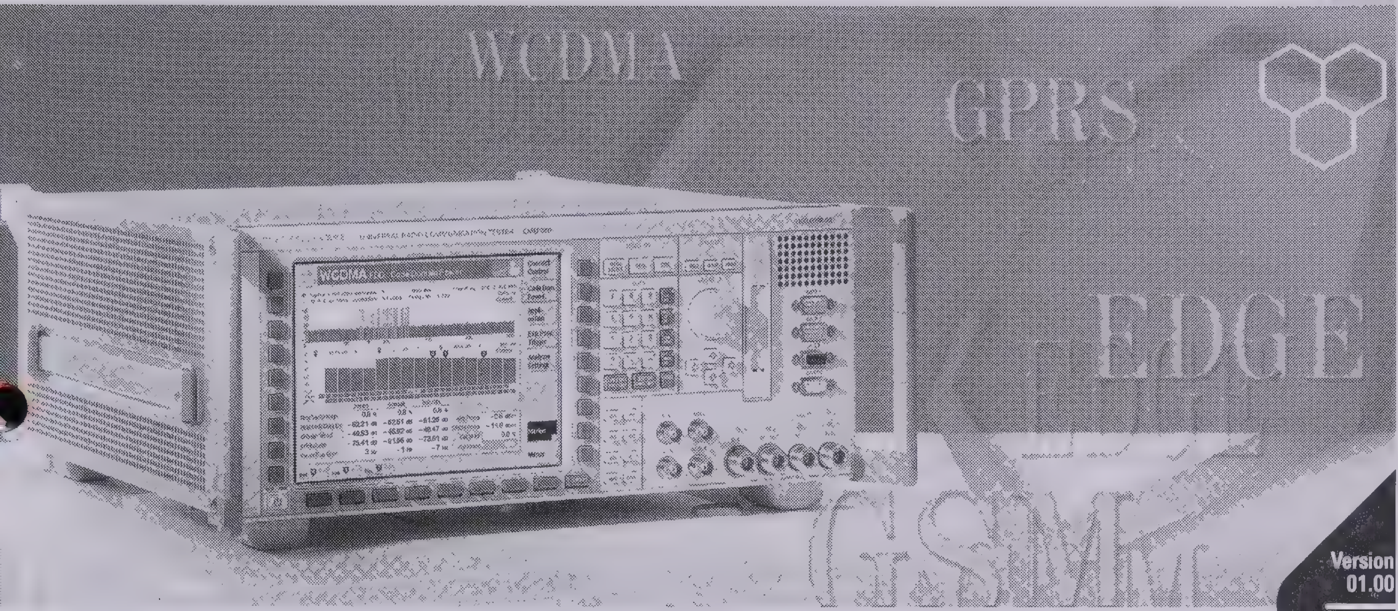
Specifications


WCDMA
GPRS
EDGE
GSM

Version
01.00

August
2003

Universal Radio Communication Tester R&S® CMU 300

Specifications

ROHDE&SCHWARZ

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The specifications for R&S CMU300 (Order No. 1100.0008.03) refer to a fully equipped unit with all options installed.

Base unit specifications

Timebase TCXO

Max. frequency drift	in temperature range +5 °C to +45 °C	±1 x 10^{-6}
Max. aging		±1 x 10^{-6}/year

Timebase OCXO – option R&S CMU-B11

Max. frequency drift	in temperature range +5 °C to +45 °C	±1 x 10^{-7}
Max. aging	after 30 days of operation	±2 x 10^{-7}/year ±5 x 10^{-9}/day
Warmup time	at +25 °C	approx. 5 min

Timebase OCXO – option R&S CMU-B12

Max. frequency drift		
	in temperature range +5°C to +45 °C, referred to +25 °C	±5 x 10^{-9}
	with instrument orientation	±3 x 10^{-9}
	referred to turn-off frequency after 2 h warmup time following a 24 h off time at +25 °C	±5 x 10^{-9}

Max. aging	after 30 days of operation	±3.5 x 10^{-8}/year ±5 x 10^{-10}/day
Warmup time	at +25 °C	approx. 10 min

Reference frequency inputs/outputs

Synchronization input		BNC connector REF IN
Frequency	sinewave squarewave (TTL level)	1 MHz to 52 MHz, step 1 kHz 10 kHz to 52 MHz, step 1 kHz
Max. frequency variation		±5 x 10^{-6}
Input voltage range		0.5 V to 2 V, rms
Impedance		50 Ω

Synchronization output 1		BNC connector REF OUT 1
Frequency		10 MHz from internal reference or frequency at synchronization input
Output voltage		>1.4 V, peak-peak
Impedance		50 Ω

Synchronization output 2		BNC connector REF OUT 2
Frequency		net-specific frequencies in range 100 kHz to 40 MHz
Output voltage	$f \leq 13$ MHz	>1.0 V, peak-peak
Impedance		50 Ω

RF generator

Frequency range		100 kHz to 2700 MHz
Frequency resolution		0.1 Hz
Frequency uncertainty		Same as timebase + frequency resolution
Frequency settling time		<400 µs to Δf < 1 kHz

Output level range		
RF 1	100 kHz to 2200 MHz	–130 dBm to –27 dBm
	2200 MHz to 2700 MHz	–130 dBm to –33 dBm
RF 2	100 kHz to 2200 MHz	–130 dBm to –10 dBm
	2200 MHz to 2700 MHz	–130 dBm to –16 dBm
RF 3 OUT	100 kHz to 2200 MHz	–90 dBm to +13 dBm
	2200 MHz to 2700 MHz	–90 dBm to +5 dBm

Output level uncertainty	in temperature range +20 °C to +35 °C	
RF 1, RF 2	output level ≥ –106 dBm	
	10 MHz to 450 MHz	<0.6 dB
	450 MHz to 2200 MHz	<0.6 dB
	2200 MHz to 2700 MHz	<0.8 dB
	output level > –117 dBm	
	450 MHz to 2200 MHz	<0.6 dB[1]
	2200 MHz to 2700 MHz	<0.8 dB[1]
	output level –117 dBm to –130 dBm	
	450 MHz to 2200 MHz	<1.5 dB[1,2]
	2200 MHz to 2700 MHz	<1.5 dB[1,2]
RF 3 OUT	10 MHz to 450 MHz	
	output level –80 dBm to +10 dBm	<0.8 dB
	450 MHz to 2200 MHz	
	output level –90 dBm to +10 dBm	<0.8 dB
	2200 MHz to 2700 MHz	
	output level –90 dBm to +5 dBm	<1.0 dB

Output level uncertainty	in temperature range +5 °C to +45 °C	
RF 1, RF 2	output level ≥ –106 dBm	
	10 MHz to 450 MHz	<1.0 dB
	450 MHz to 2200 MHz	<1.0 dB
	2200 MHz to 2700 MHz	<1.5 dB
	output level > –117 dBm	
	450 MHz to 2200 MHz	<1.0 dB[1]
	2200 MHz to 2700 MHz	<1.5 dB[1]
	output level –117 dBm to –130 dBm	
	450 MHz to 2200 MHz	<1.5 dB[1,2]
	2200 MHz to 2700 MHz	<1.5 dB[1,2]
RF 3 OUT	10 MHz to 450 MHz	
	output level –80 dBm to +10 dBm	<1.0 dB
	450 MHz to 2200 MHz	
	output level –90 dBm to +10 dBm	<1.0 dB
	2200 MHz to 2700 MHz	
	output level –90 dBm to +5 dBm	<1.5 dB

Output level settling time		<4 µs

Output level resolution		0.1 dB

Generator RF level repeatability	typical values after 1 h warmup time	
	output level ≥ –80 dBm	<0.01 dB
	output level < –80 dBm	<0.1 dB

---

[1] Not valid at frequencies of net-clock harmonics.

[2] Valid for RF1 only.

VSWR		
RF 1	10 MHz to 2000 MHz 2000 MHz to 2200 MHz 2200 MHz to 2700 MHz	<1.2 <1.3 <1.6
RF 2	10 MHz to 2200 MHz 2200 MHz to 2700 MHz	<1.2 <1.6
RF 3 OUT	10 MHz to 2200 MHz 2200 MHz to 2700 MHz	<1.5 <1.7

Attenuation of harmonics	f_0 = 10 MHz to 2200 MHz, up to 7 GHz	
RF 1, RF 2		>30 dB
RF 3 OUT	output level ≤ +10 dBm	>20 dB

Attenuation of nonharmonics	10 MHz to 2200 MHz, at f > 5 kHz from carrier	>40 dB

Phase noise	single sideband, f < 2.2 GHz	
Carrier offset	20 kHz to 250 kHz ≥250 kHz	<–100 dBc, 1 Hz <–110 dBc, 1 Hz

Residual FM	30 Hz to 15 kHz ITU-T (formerly CCITT)	<50 Hz, rms, <200 Hz, peak <5 Hz, rms

Residual AM	ITU-T (formerly CCITT)	<0.02%, rms

I/Q modulation		
Carrier suppression	data for frequency offset range 0 kHz to ±135 kHz	>40 dB

RF analyzer

VSWR		
RF 1	10 MHz to 2000 MHz 2000 MHz to 2200 MHz 2200 MHz to 2700 MHz	<1.2 <1.3 <1.6
RF 2	10 MHz to 2200 MHz 2200 MHz to 2700 MHz	<1.2 <1.6
RF 3 OUT	10 MHz to 2200 MHz 2200 MHz to 2700 MHz	<1.5 <1.6

Phase noise	single sideband, f < 2.2 GHz	
Carrier offset	20 kHz to 250 kHz 250 kHz to 400 kHz ≥400 kHz	<–100 dBc, 1 Hz <–110 dBc, 1 Hz <–118 dBc, 1 Hz

Residual FM	30 Hz to 15 kHz ITU–T (formerly CCITT)	<50 Hz, rms, <200 Hz, peak <5 Hz, rms

Residual AM	ITU–T (formerly CCITT)	<0.02%, rms

Power meter (wideband)

Frequency range		100 kHz to 2700 MHz
Level range		
RF 1	continuous power[3]	
	100 kHz to 2200 MHz	+6 dBm to +47 dBm (50 W)
	2200 MHz to 2700 MHz	+10 dBm to +47 dBm (50 W)
	peak envelope power[4] (PEP)	+53 dBm (200 W)
RF 2	continuous power	
	100 kHz to 2200 MHz	–8 dBm to +33 dBm (2 W)
	2200 MHz to 2700 MHz	–4 dBm to +33 dBm (2 W)
	peak envelope power[4] (PEP)	+39 dBm (8 W)
RF 4 IN	continuous power and PEP	
	100 kHz to 2200 MHz	–33 dBm to 0 dBm
	2200 MHz to 2700 MHz	–29 dBm to 0 dBm
Level uncertainty		
RF 1	input level +10 dBm to +20 dBm	
	50 MHz to 2700 MHz	<1.0 dB[5]
	input level +20 dBm to +47 dBm	
	50 MHz to 2700 MHz	<0.5 dB[5,6]
RF 2	input level –4 dBm to +6 dBm	
	50 MHz to 2700 MHz	<1.0 dB[5]
	input level +6 dBm to +33 dBm	
	50 MHz to 2700 MHz	<0.5 dB[5]
RF 4 IN	input level –29 dBm to –19 dBm	
	50 MHz to 2700 MHz	<1.5 dB
	input level –19 dBm to 0 dBm	
	50 MHz to 2700 MHz	<0.8 dB
Level resolution		0.1 dB (0.01 dB in remote control mode)

Power meter (frequency-selective)

Frequency range		10 MHz to 2700 MHz
Frequency resolution		0.1 Hz
Resolution bandwidths		10 Hz to 1 MHz in 1/2/3/5 steps
Level range		
RF 1	continuous power[3]	
	10 MHz to 2200 MHz	–40 dBm to +47 dBm (50 W)
	2200 MHz to 2700 MHz	–34 dBm to +47 dBm (50 W)
	peak envelope power[4] (PEP)	+53 dBm (200 W)
RF 2	continuous power	
	10 MHz to 2200 MHz	–54 dBm to +33 dBm (2 W)
	2200 MHz to 2700 MHz	–48 dBm to +33 dBm (2 W)
	peak envelope power[4] (PEP)	+39 dBm (8 W)
RF 4 IN	continuous power and PEP	
	10 MHz to 2200 MHz	–80 dBm to 0 dBm
	2200 MHz to 2700 MHz	–74 dBm to 0 dBm

---

[3] 50 W in temperature range +5 °C to +30 °C, linear degradation down to 25 W at +45 °C.

[4] Mean value of power vs time must be equal to or less than allowed continuous power.

[5] Temperature range +5 °C to +20 °C or +35 °C to +45 °C and f > 2200 MHz: add 0.2 dB.

[6] Calibrated for input level > 33 dBm only in frequency range 800 MHz to 2000 MHz.

Level uncertainty	in temperature range +20 °C to +35 °C	
RF 1, RF 2	50 MHz to 2200 MHz 2200 MHz to 2700 MHz	<0.5 dB <0.7 dB
RF 4 IN	50 MHz to 2200 MHz 2200 MHz to 2700 MHz	<0.7 dB <0.9 dB

Level uncertainty	in temperature range +5 °C to +45 °C	
RF 1, RF 2	50 MHz to 2200 MHz 2200 MHz to 2700 MHz	<1.0 dB <1.0 dB
RF 4 IN	50 MHz to 2200 MHz 2200 MHz to 2700 MHz	<1.0 dB <1.1 dB

Level resolution		0.1 dB (0.01 dB in remote control mode)

RF level measurement repeatability	typical values after 1 h warmup	
	input level ≥ –40 dBm	<0.01 dB
	input level < –40 dBm	<0.03 dB

Spectrum analyzer

Frequency range		10 MHz to 2.7 GHz
Span		zero span to full span
Frequency resolution		0.1 Hz
Resolution bandwidths		10 Hz to 1 MHz in 1/2/3/5 steps
Sweep time	depending on RBW	≥100 ms
Display		560 dots, horizontal
Marker		up to 3, absolute/relative
Display line		1
Display scale		10/20/30/50/80/100 dB

Level range		
RF 1	continuous power[3] peak envelope power[4] (PEP)	up to +47 dBm (50 W) up to +53 dBm (200 W)
RF 2	continuous power peak envelope power[4](PEP)	up to +33 dBm (2 W) up to +39 dBm (8 W)
RF 4 IN	continuous power and PEP	up to 0 dBm

Level uncertainty	in temperature range +20 °C to +35 °C	
RF 1, RF 2	50 MHz to 2200 MHz 2200 MHz to 2700 MHz	<0.5 dB <0.7 dB
RF 4 IN	50 MHz to 2200 MHz 2200 MHz to 2700 MHz	<0.7 dB <0.9 dB

Level uncertainty	in temperature range +5 °C to +45 °C	
RF 1, RF 2	50 MHz to 2200 MHz 2200 MHz to 2700 MHz	<1.0 dB <1.0 dB
RF 4 IN	50 MHz to 2200 MHz 2200 MHz to 2700 MHz	<1.0 dB <1.1 dB

Reference level for full dynamic range	*RF Attenuation → Low Noise*, logarithmic level display	
RF 1		+10 dBm to +47 dBm
RF 2		–4 dBm to +33 dBm
RF 4 IN		–22 dBm to 0 dBm

Displayed average noise level	*RF Attenuation → Low Noise ,* *RBW → 1 kHz,*	
	10 MHz to 2200 MHz	<–100 dBc
	2200 MHz to 2700 MHz	<–95 dBc

Inherent spurious response	*RF Attenuation → Low Distortion,* 20 MHz to 2200 MHz, except 1816.115 MHz	<–50 dB

Inherent harmonics	f_0 = 50 MHz to 2200 MHz, up to 7 GHz	
RF 1, RF 2		<–30 dB
RF 4 IN		<–20 dB

General specifications

Operating temperature range		+5 °C to +45 °C, meets EN60068-2-1 and -2
Storage temperature range		–25 °C to +60 °C, meets EN60068-2-1 and -2
Humidity	+40 °C, non-condensing	80% relative humidity, meets EN 60068-2-3

Electromagnetic compatibility		meets EMC Directive 89/336/EEC, applied Standard: EN 61326 (immunity for industrial environment; class B emissions)

Electrical safety		IEC 61010-1, EN 61010-1, UL3111-1, CAN/CSA-C22.2 No. 1010.1

Mechanical resistance	non-operating mode	
Vibration	sinusoidal	meets EN 60068-2-6, EN 61010-1, MIL-T-28800 D class 5, 5 Hz to 150 Hz, max. 2 g at 55 Hz, 55 Hz to 150 Hz, 0.5 g const
Vibration	random	meets EN 60068-2-64 10 Hz to 300 Hz, acceleration 1.2 g rms
Shock		meets EN 60068-2-27, MIL-STD-810D 40 g shock spectrum

Power supply		power factor correction, meets EN61000-3-2
Input		100 V to 240 V ±10% (AC), max. 500 VA, 50 Hz to 400 Hz –5% to +10%
Power consumption	base unit with typical options	approx. 130 W approx. 180 W

Display		21 cm TFT colour display (8.4")
Resolution		640 x 480 pixels (VGA resolution)
Pixel failure rate		<2 x 10^{-5}

Dimensions	W x H x D	465 mm x 193 mm x 517 mm (19"; 4 height units)

Weight	base unit with typical options	approx. 14 kg approx. 18 kg

Inputs and outputs (rear panel)

IF 3 RX CH1		BNC female
Frequency	WCDMA other networks/RF	7.68 MHz/10 MHz 10.7 MHz
Max. output level		0 dBm
Impedance		50 Ω

Remote control interfaces		
IEC/IEEE bus	IEC 60625-2 (IEEE 488.2)	24-pin Amphenol connector
Serial interface COM 1, COM 2	RS-232-C (COM)	9-pin sub-D connector

Printer interface LPT	parallel (Centronics compatible)	25-pin sub-D connector

Keyboard		PS/2 connector

External monitor (VGA)		15-pin sub-D connector

GSM specifications – base station test

RF generator

Modulation		GMSK, BxT = 0.3 8PSK
Frequency range		
	GSM400 band	450 MHz to 458 MHz 478 MHz to 486 MHz
	GSM850 band	824 MHz to 849 MHz
	GSM900 band	876 MHz to 915 MHz
	GSM1800 band	1710 MHz to 1785 MHz
	GSM1900 band	1850 MHz to 1910 MHz
Attenuation of inband spurious emissions		>50 dB
Inherent phase error	GMSK	<1°, rms <4°, peak
Inherent EVM	8PSK	<2%, rms
Frequency settling time	to residual phase of 4°	<500 µs
Output level range	GMSK	
RF 1		–130 dBm to –27 dBm
RF 2		–130 dBm to –10 dBm
RF 3 OUT		–90 dBm to +13 dBm
Output level range	8PSK	
RF 1		–130 dBm to –31 dBm
RF 2		–130 dBm to –14 dBm
RF 3 OUT		–90 dBm to +9 dBm
Output level resolution		0.1 dB
Output level uncertainty	in temperature range +20 °C to 35 °C	
RF 1, RF 2	output level > –117 dBm	<0.5 dB
RF 3 OUT	–90 dBm to +10 dBm (GMSK)	<0.7 dB
	–90 dBm to +6 dBm (8PSK)	<0.7 dB
Output level uncertainty	in temperature range +5 °C to 45 °C	
RF 1, RF 2	output level > –117 dBm	<0.7 dB
RF 3 OUT	–90 dBm to +10 dBm (GMSK)	<0.9 dB
	–90 dBm to +6 dBm (8PSK)	<0.9 dB

RF analyzer

Frequency range		
	GSM400 band	460 MHz to 468 MHz 488 MHz to 496 MHz
	GSM850 band	869 MHz to 894 MHz
	GSM900 band	921 MHz to 960 MHz
	GSM1800 band	1805 MHz to 1880 MHz
	GSM1900 band	1930 MHz to 1990 MHz

Power meter (frequency-selective)

Level range		
RF 1	continuous power[3] peak envelope power[4] (PEP)	–40 dBm to +47 dBm (50 W) +53 dBm (200 W)
RF 2	continuous power peak envelope power[4] (PEP)	–54 dBm to +33 dBm (2 W) +39 dBm (8 W)
RF 4 IN	continuous power and PEP	–80 dBm to 0 dBm

Level uncertainty	in temperature range +20 °C to +35 °C in temperature range +5 °C to +45 °C	<0.5 dB <0.7 dB

Level resolution		0.1 dB (0.01 dB in remote control mode)

Measurement bandwidth		500 kHz or 600 kHz, selectable

Modulation analysis

Level range	peak envelope power (PEP)	
RF 1	see footnote[4]	–6 dBm to +53 dBm
RF 2	see footnote[4]	–20 dBm to +39 dBm
RF 4 IN		–60 dBm to 0 dBm

Inherent phase error	GMSK	<0.6°, rms <2°, peak

Inherent EVM	8PSK	≤1.0 %, rms

Frequency measurement uncertainty		≤10 Hz + drift of timebase (see base unit specifications)

Measurement bandwidth		500 kHz or 600 kHz, selectable

Burst power measurement

Reference level for full dynamic range	GMSK, *RF Attenuation → Low Noise*	
RF 1	see footnote[4]	+10 dBm to +53 dBm
RF 2	see footnote[4]	–4 dBm to +39 dBm
RF 4 IN		–22 dBm to 0 dBm

Reference level for full dynamic range	8PSK, *RF Attenuation → Low Noise*	
RF 1	see footnote[4]	+6 dBm to +49 dBm
RF 2	see footnote[4]	–8 dBm to +35 dBm
RF 4 IN		–26 dBm to –4 dBm

Dynamic range	*Filter → 500 kHz*, rms, *RF Attenuation → Low Noise*	
	GMSK	>72 dB
	8PSK	>69 dB

Relative measurement uncertainty		
	result > –40 dB	<0.1 dB
	–60 dB < result < –40 dB	<0.5 dB

Resolution	in active part of burst	0.1 dB

Measurement bandwidth		500 kHz or 600 kHz, selectable

Spectrum due to modulation[7]

Reference level for full dynamic range	GMSK, *RF Attenuation → Low Noise*	
RF 1		+10 dBm to +47 dBm
RF 2		–4 dBm to +33 dBm
RF 4 IN		–22 dBm to 0 dBm

Test method		relative measurement, averaging

Filter bandwidth		30 kHz resolution filter, 5 pole

Measurement	at an offset of	100, 200, 250, 400, 600, 800, 1000, 1200, 1400, 1600, 1800 kHz

Dynamic range	*Noise Correction → On*, with offset ≥ 1200 kHz	>80 dB

Spectrum due to switching[7]

Reference level for full dynamic range	GMSK, *RF Attenuation → Low Noise*	
RF 1		+10 dBm to +47 dBm
RF 2		–4 dBm to +33 dBm
RF 4 IN		–22 dBm to 0 dBm

Test method		absolute measurement, max. hold over several measurements

Filter bandwidth		30 kHz resolution filter, 5 pole

Measurement	at an offset of	400, 600, 800, 1200, 1800 kHz

Dynamic range	*Noise Correction → On*, with offset ≥ 1200 kHz	>80 dB

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[7] The specifications apply to all cases in which interfering carriers (up to the same level as the measured carrier) are more than 50 GSM channels away.

WCDMA specifications – base station test

Standard		3GPP FDD
Symbol rate		3.84 MHz
Trigger input	15 pin sub–D connector AUX 3, pin 6	TTL level
Required trigger signals	physical channel mode reference channel mode	10 ms frame trigger TTI trigger (20 ms, 40 ms, 80 ms)

RF generator (3GPP FDD, release 99, uplink signal)

Physical channels	1 x DPCCH, 1 to 6 x DPDCH	15 kbps, 30 kbps, 60 kbps, 120 kbps, 480 kbps, 1 x 960 kbps, 2 x 960 kbps, 3 x 960 kbps, 4 x 960 kbps, 5 x 960 kbps, 6 x 960 kbps
Amplitude ratio of ßc to ßd		15/15, 14/15, 13/15, 12/15, 11/15, 10/15, 9/15, 8/15, 7/15, 6/15, 5/15, 4/15, 3/15, 2/15, 1/15, DPDCH off
Reference measurement channel	3GPP TS 25.141	12.2 kbps, 64 kbps, 144 kbps, 384 kbps, 2048 kbps

Frequency range		1850 MHz to 1910 MHz 1920 MHz to 1980 MHz

Frequency resolution		0.1 Hz

Output level range		
RF 1		–130 dBm to –40 dBm
RF 2		–130 dBm to –23 dBm
RF 3 OUT		–90 dBm to 0 dBm

Output level uncertainty	in temperature range +20 °C to +35 °C	
RF 1, RF 2	output level ≥ –125 dBm	<0.6 dB
RF 3 OUT	output level ≥ –80 dBm	<0.8 dB

Output level uncertainty	in temperature range +5 °C to +45 °C	
RF 1, RF 2	output level ≥ –125 dBm	<0.9 dB
RF 3 OUT	output level ≥ –80 dBm	<1.0 dB

Signal quality		
Error vector magnitude (EVM)		<8 %[8], rms

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[8] Global EVM for UL 3GPP reference measurement channels.

RF analyzer (TX measurements)

Frequency range	1930 MHz to 1990 MHz 2110 MHz to 2170 MHz

Frequency resolution	1 Hz

Modulation analysis[9,10]

Measurement filter	receiver filter according to standard	3.84 MHz, RRC, $\alpha = 0.22$
Analysis modes		WCDMA downlink

Reference level for full dynamic range		
RF 1	continuous power[3]	0 dBm to +47 dBm
	peak envelope power[4] (PEP)	0 dBm to +53 dBm
RF 2	continuous power	–14 dBm to +33 dBm
	peak envelope power[4] (PEP)	–14 dBm to +39 dBm
RF 4 IN	continuous power and PEP	–37 dBm to 0 dBm

Error vector magnitude (EVM)		
Measurement range		up to 25 %
Inherent EVM		<2.5 %[11] rms
Resolution		0.1 %

Frequency error		
Measurement range		±1 kHz
Uncertainty		<5 Hz[12] + drift of timebase
Resolution		1 Hz

IQ offset		
Inherent IQ offset		<–50 dB
Resolution		0.01 dB

IQ imbalance		
Inherent IQ imbalance		<–50 dB
Resolution		0.01 dB

Peak code domain error (PCDE)		
Inherent PCDE		<–40 dB
Resolution		0.01 dB

Spectrum measurements

Reference level for full dynamic range	test model 1	
RF 1	rms	+19 dBm to +41 dBm
	peak envelope power[4](PEP)	+31 dBm to +53 dBm
RF 2	rms	+5 dBm to +27 dBm
	peak envelope power[4](PEP)	+17 dBm to +39 dBm
RF 4 IN	rms	–18 dBm to –12 dBm
	peak envelope power (PEP)	–6 dBm to 0 dBm

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[9] The specified data is valid for *RF Attenuation* set to *Normal*.

[10] With 3GPP TS 25.141 test model 04 inclusive CPICH.

[11] With R&S CMU–Z6 <1.5 %, rms typ.

[12] Specified for average value of ≥10 slots.

ACLR		
Measurement filter	receiver filter according to standard	3.84 MHz, RRC, α=0.22
Frequency offsets	first adjacent channel second adjacent channel	±5 MHz ±10 MHz
Dynamic range *(ACLR Scanning → Off)*	first adjacent channel second adjacent channel	>54 dB >62 dB
Dynamic range (*ACLR Scanning → On*)	first adjacent channel second adjacent channel	>60 dB[13] >70 dB[13]
Uncertainty	relative	<0.8 dB[14] typ.
Resolution		0.1 dB

Occupied bandwidth		
Range		1 MHz to 6 MHz
Uncertainty		<100 kHz
Resolution		20 kHz

Power meter (wideband)

See base unit specifications		

Power meter (frequency-selective)[15]

Maximum output power	wideband filter receiver filter according to standard	Bandwidth approx. 7 MHz 3.84 MHz, RRC, α = 0.22

Level range		
RF 1	continuous power[3] peak envelope power[4] (PEP)	–52 dBm to +47 dBm –42 dBm to +53 dBm
RF 2	continuous power peak envelope power[4] (PEP)	–66 dBm to +33 dBm –56 dBm to +39 dBm
RF 4 IN	continuous power[16] peak envelope power (PEP)	–89 dBm to 0 dBm –79 dBm to 0 dBm

Level uncertainty	in temperature range +20 °C to +35 °C	
RF 1	–10 dBm to +47 dBm, rms –44 dBm to –10 dBm, rms	<0.5 dB <0.7 dB
RF 2	–24 dBm to +33 dBm, rms –60 dBm to –24 dBm, rms	<0.5 dB <0.7 dB
RF 4 IN	–24 dBm to 0 dBm, rms –85 dBm to –24 dBm, rms	<0.5 dB <0.7 dB

Level uncertainty	in temperature range +5 °C to +45 °C	
RF 1	–10 dBm to +47 dBm, rms –44 dBm to –10 dBm, rms	<0.7 dB <0.9 dB
RF 2	–24 dBm to +33 dBm, rms –60 dBm to –24 dBm, rms	<0.7 dB <0.9 dB
RF 4 IN	–24 dBm to 0 dBm, rms –85 dBm to –24 dBm, rms	<0.7 dB <0.9 dB

Level resolution		0.01 dB

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[13] The specified data is valid for units delivered since 08/2003 or with R&S CMU-U74.

[14] For power difference <50 dB and full range carrier power level.

[15] The specified data is valid for *RF Attenuation* set to *Low Noise*.

[16] Upper limit depends on crest factor.

Code domain power [15]

Measurement filter	receiver filter according to standard	3.84 MHz, RRC, $\alpha = 0.22$

Level range		
RF 1		–8 dBm to +47 dBm
RF 2		–22 dBm to +33 dBm
RF 4 IN		–45 dBm to 0 dBm

Level uncertainty		<0.5 dB

Level resolution		0.01 dB

Option IQ/IF Interface R&S CMU-B17

IQ interface

Analog IQ outputs	IF → IQ; TX and RX paths, analog I/Q output	connector I/Q CH1
IQ bandwidth		0 MHz to 2.5 MHz
Max. output voltage range	EMF	–1 V to +1 V, peak $\sqrt{I^2+Q^2}$ = 1 V, peak
Output impedance		50 Ω
I and Q amplitude imbalance		<2 %
Offset voltage	in temperature range +20 °C to +35 °C in temperature range +5 °C to +45 °C	<4 mV <8 mV

Analog IQ inputs	IQ → IF; TX–path, analog I/Q input	Connector I/Q CH1
IQ bandwidth		0 MHz to 2.5 MHz
Max input voltage range		–0.5 V to +0.5 V, peak $\sqrt{I^2+Q^2}$ = 0.5 V, peak
Input impedance		50 Ω
Carrier suppression	in temperature range +20 °C to +35 °C in temperature range +5 °C to +45 °C	>40 dB >35 dB
Sideband suppression	$f_{iq} < 1$ MHz 1MHz < f_{iq} < 2.5 MHz	>45 dB >40 dB

Analog IQ inputs	IQ → IF; RX path, analog I/Q input	connector I/Q CH1
IQ bandwidth		0 MHz to 2.5 MHz
Max. input voltage range		–0.5 V to +0.5 V, peak $\sqrt{I^2+Q^2}$ = 0.5 V, peak
Input impedance		50 Ω
Carrier suppression	in temperature range +20 °C to +35 °C in temperature range +5 °C to +45 °C	>35 dB[17] >35 dB[17]
Side band suppression	$f_{iq} < 1$ MHz 1 MHz < f_{iq} < 2.5 MHz	>45 dB >40 dB

Influence on RF interface

GSM/EDGE measurements		
Additional influence on signal quality	analog I/Q input and output considered; for TX and RX paths	
Phase error	GMSK	<3°, peak <1°, rms
EVM	8PSK	<5 %, rms

RF level uncertainty	bypass with I/Q IF OUT, I/Q IN/OUT, IF IN/OUT	
Output level uncertainty	at RF 1, RF 2, RF 3 OUT	add 0.3 dB to R&S CMU300 base unit specifications
Input level uncertainty of frequency-selective power meter	at RF 1, RF 2, RF 4 IN	add 0.3 dB to R&S CMU300 base unit specifications

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[17] For GSMK modulation and max. input voltage at IQ inputs.

IF interface

IF inputs, TX path		connector IF3 TX CH1 IN
IF level range		up to –5 dBm, PEP
Standard IF frequencies	RF/GSM (GMSK and 8PSK)	13.85 MHz

IF inputs, RX path		connector IF3 RX CH1 IN
IF level range		up to +2 dBm, PEP
Standard IF frequencies	RF/GSM (GMSK and 8PSK)	10.7 MHz

IF outputs, TX path		connector IF3 TX CH1 OUT
IF level range		up to –5 dBm, PEP
Standard IF frequencies	RF/GSM (GMSK and 8PSK)	13.85 MHz

IF outputs, RX path		connector IF3 RX CH1 OUT
IF level range		up to +6 dBm, PEP
Standard IF frequencies	RF/GSM (GMSK and 8PSK)	10.7 MHz

Remarks

Aspects to be considered if TX or RX signal paths are interrupted:

The RF frequency of the R&S CMU300 influences the rotating direction of the IQ vector.
The direction is inverted for f < 1200.1 MHz; this can be compensated for by changing I and Q.

	R&S CMU300 generator or analyzer RF frequency	
	100 kHz to 1200.0999999 MHz	1200.1 MHz to 2700.0 MHz
R&S CMU300 IQ output vector	inverted rotation swap I output with Q output for proper operation	normal rotation
R&S CMU300 IQ input vector	inverted rotation swap I input with Q input for proper operation	normal rotation

The rotating direction must be considered if the R&S CMU300 signal path from the link handler board to the frontend and vice versa is interrupted, i.e. if the signal is not returned to the same R&S CMU300 block after external handling.

Examples:

- The rotating direction must **not** be taken into account if the transmitted signal is routed from the IQ output of the R&S CMU-B17 to an external fading simulator and then returned to the R&S CMU300 IQ input (the R&S CMU300 in combination with the Fading Simulator R&S ABFS or R&S SMIQ/SMIQB14, the R&S CMU300 providing the faded RF signal).
- The rotating direction must be considered, if the transmitted signal is forwarded to an external fading simulator and is not returned to the IQ input of the R&S CMU300 (the R&S CMU300 in combination with the R&S SMIQ, the R&S SMIQ providing the faded RF signal).

Notes for measuring IQ/IF signals applied to inputs of the R&S CMU-B17 option on the R&S CMU300 RX path:

- The RF spectrum analyzer function (RF function group) cannot be used.
- The displayed RF power levels are not related directly to the applied IQ/IF voltages. The analyzer settings of the R&S CMU300 RF interface (RF 1, RF 2, RF 4 IN) have to be considered additionally (*Analyzer Level → RF Max. Level*).
- IQ inputs have a fixed attenuation of 2 dB; e.g. the RF power meter readout for an applied 500 mV IQ peak voltage will be 2 dB below the set value in *RF Max. Level*.
- IF inputs do not have a fixed attenuation. The max. IF input level is 2 dBm. The RF power meter readout for the mentioned max. IF signal level (2 dBm) will be 2 dB below the set value in *RF Max. Level*.
- We recommend switching off the autoranging function.
- RF and IF trigger functions are not possible.

The specifications for R&S CMU300 (Order No. 1100.0008.03) refer to a fully equipped unit with all options installed.

Specifications are valid under the following conditions:

Data without tolerance limits is not binding.

In compliance with the 3GPP standard, chip rates are specified in Mcps (million chips per second), whereas bit rates and symbol rates are specified in kbps (thousand bits per second) or ksps (thousand symbols per second).

Mcps, kbps and ksps are not SI units.

For more general information about the R&S CMU300 please refer to the product brochure PD 0758.0000.12, version ≥01.00.

ISO 9001

ISO 14001

ROHDE&SCHWARZ

Rohde & Schwarz GmbH & Co. KG · Mühldorfstraße 15 · 81671 München · Germany · P.O.B. 801469 · 81614 München · Germany · Telephone +49 89 4129–0
www.rohde–schwarz.com · Customer Support: Telephone +49 180 512 4242, Fax +49 89 4129–13777, E–mail: CustomerSupport@rohde–schwarz.com

PD 0758.0000.22 · Universal Radio Communication Tester R&S CMU 300 · Version 01.00 · August 2003

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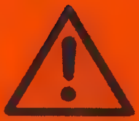
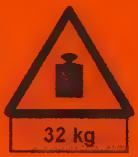
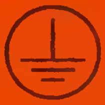
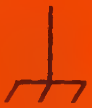
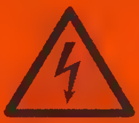
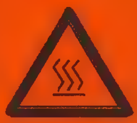
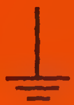
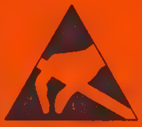
Printed in Germany (Bi as)

Safety Instructions

This unit has been designed and tested in accordance with the EC Certificate of Conformity and has left the manufacturer's plant in a condition fully complying with safety standards.

To maintain this condition and to ensure safe operation, the user must observe all instructions and warnings given in this operating manual.

Safety-related symbols used on equipment and documentation from R&S:

							
Observe operating instructions	Weight indication for units >18 kg	PE terminal	Ground terminal	Danger! Shock hazard	Warning! Hot surfaces	Ground	Attention! Electrostatic sensitive devices require special care

1. The unit may be used only in the operating conditions and positions specified by the manufacturer. Unless otherwise agreed, the following applies to R&S products:

   IP degree of protection 2X, pollution severity 2 overvoltage category 2, only for indoor use, altitude max. 2000 m.

   The unit may be operated only from supply networks fused with max. 16 A.

   Unless specified otherwise in the data sheet, a tolerance of ±10% shall apply to the nominal voltage and of ±5% to the nominal frequency.

2. For measurements in circuits with voltages $V_{rms} > 30$ V, suitable measures should be taken to avoid any hazards.

   (using for example, appropriate measuring equipment, fusing, current limiting, electrical separation, insulation).

3. If the unit is to be permanently wired, the PE terminal of the unit must first be connected to the PE conductor on site before any other connections are made. Installation and cabling of the unit to be performed only by qualified technical personnel.

4. For permanently installed units without built-in fuses, circuit breakers or similar protective devices, the supply circuit must be fused such as to provide suitable protection for the users and equipment.

5. Prior to switching on the unit, it must be ensured that the nominal voltage set on the unit matches the nominal voltage of the AC supply network.

   If a different voltage is to be set, the power fuse of the unit may have to be changed accordingly.

6. Units of protection class I with disconnectible AC supply cable and appliance connector may be operated only from a power socket with earthing contact and with the PE conductor connected.

7. It is not permissible to interrupt the PE conductor intentionally, neither in the incoming cable nor on the unit itself as this may cause the unit to become electrically hazardous.

   Any extension lines or multiple socket outlets used must be checked for compliance with relevant safety standards at regular intervals.

8. If the unit has no power switch for disconnection from the AC supply, the plug of the connecting cable is regarded as the disconnecting device. In such cases it must be ensured that the power plug is easily reachable and accessible at all times (length of connecting cable approx. 2 m). Functional or electronic switches are not suitable for providing disconnection from the AC supply.

   If units without power switches are integrated in racks or systems, a disconnecting device must be provided at system level.

9. Applicable local or national safety regulations and rules for the prevention of accidents must be observed in all work performed.

   Prior to performing any work on the unit or opening the unit, the latter must be disconnected from the supply network.

   Any adjustments, replacements of parts, maintenance or repair may be carried out only by authorized R&S technical personnel.

   Only original parts may be used for replacing parts relevant to safety (eg power switches, power transformers, fuses). A safety test must be performed after each replacement of parts relevant to safety.

   (visual inspection, PE conductor test, insulation-resistance, leakage-current measurement, functional test).

continued overleaf

Safety Instructions

10. Ensure that the connections with information technology equipment comply with IEC950/EN60950.

11. Lithium batteries must not be exposed to high temperatures or fire.

    Keep batteries away from children.

    If the battery is replaced improperly, there is danger of explosion. Only replace the battery by R&S type (see spare part list).

    Lithium batteries are suitable for environmentally-friendly disposal or specialized recycling. Dispose them into appropriate containers, only.

    Do not short-circuit the battery.

12. Equipment returned or sent in for repair must be packed in the original packing or in packing with electrostatic and mechanical protection.

13. Electrostatics via the connectors may damage the equipment. For the safe handling and operation of the equipment, appropriate measures against electrostatics should be implemented.

14. The outside of the instrument is suitably cleaned using a soft, lint-free dustcloth. Never use solvents such as thinners, acetone and similar things, as they may damage the front panel labeling or plastic parts.

15. Any additional safety instructions given in this manual are also to be observed.

Certified Quality System
ISO 9001
DQS REG. NO 1954 QM

Certified Environmental System
ISO 14001
DQS REG. NO 1954 UM

Qualitätszertifikat

Sehr geehrter Kunde,

Sie haben sich für den Kauf eines Rohde & Schwarz-Produktes entschieden. Hiermit erhalten Sie ein nach modernsten Fertigungsmethoden hergestelltes Produkt. Es wurde nach den Regeln unseres Qualitätsmanagementsystems entwickelt, gefertigt und geprüft. Das Rohde & Schwarz-Qualitätsmanagementsystem ist u.a. nach ISO 9001 und ISO 14001 zertifiziert.

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Certificat de qualité

Cher client,

Vous avez choisi d'acheter un produit Rohde & Schwarz. Vous disposez donc d'un produit fabriqué d'après les méthodes les plus avancées. Le développement, la fabrication et les tests respectent nos normes de gestion qualité. Le système de gestion qualité de Rohde & Schwarz a été homologué, entre autres, conformément aux normes ISO 9001 et ISO 14001.

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EC Certificate of Conformity

CE

Certificate No.: 99035, page 1

This is to certify that:

Equipment type	Stock No.	Designation
CMU200	1100.0008.02/.53	Universal Radio Communication Tester
CMU300	1100.0008.03	

complies with the provisions of the Directive of the Council of the European Union on the approximation of the laws of the Member States

- relating to electrical equipment for use within defined voltage limits (73/23/EEC revised by 93/68/EEC)
- relating to electromagnetic compatibility (89/336/EEC revised by 91/263/EEC, 92/31/EEC, 93/68/EEC)

Conformity is proven by compliance with the following standards:

EN61010-1 : 1993 + A2 : 1995
EN61326-1 : 1997 + A1 : 1998

For the assessment of electromagnetic compatibility, the limits of radio interference for Class B equipment as well as the immunity to interference for operation in industry have been used as a basis.

Affixing the EC conformity mark as from 1999

ROHDE & SCHWARZ GmbH & Co. KG
Mühldorfstr. 15, D-81671 München
Central Quality Management FS-QZ / Becker

Munich, 2002-11-28

Certificate No.: 99035, page 2

This is to certify that:

Equipment type	Stock No.	Designation
CMU-B11	1100.5000.02	Reference Oscillator
CMU-B12	1100.5100.02	Reference Oscillator
CMU-B15	1100.6006.02	Additional RF und IF Connections
CMU-B17	1100.6906.02	IQ and IF Interfaces
CMU-B21	1100.5200.02	Versatile Signalling Unit
CMU-B41	1100.5300.02	Audio Generator and Analyzer
CMU-B52	1100.5400.02	Spreech Codec for Versatile Signalling Unit
CMU-B53	1100.5700.02	Bluetooth Extension
CMU-B66	1149.9509.02	Versatile Base Band Board
CMU-B68	1149.9809.02	Layer1 Board
CMU-B71	1100.6406.02	ABIS Interface Unit
CMU-B73	1150.2004.02	Analog Telephon Line Interface
CMU-B76	1150.0601.02	Layer1 Board for WCDMA

complies with the provisions of the Directive of the Council of the European Union on the approximation of the laws of the Member States

- relating to electrical equipment for use within defined voltage limits (73/23/EEC revised by 93/68/EEC)
- relating to electromagnetic compatibility (89/336/EEC revised by 91/263/EEC, 92/31/EEC, 93/68/EEC)

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ROHDE & SCHWARZ GmbH & Co. KG
Mühldorfstr. 15, D-81671 München
Munich, 2002-09-02
Central Quality Management FS-QZ / Becker

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EC Certificate of Conformity

CE

Certificate No.: 99035, page 3

This is to certify that:

Equipment type	Stock No.	Designation
CMU-B81	1100.6506.02	CDMA(IS95) Signalling Unit
CMU-B82	1150.0201.02/.04	ACCESS Board für CDMA Signalling Unit
CMU-B83	1150.0301.02/.04 1150.0301.12/.14	CDMA2000 Signalling Unit
CMU-B85	1100.7002.02/.04	Speech Codec for CDMA2000
CMU-B87	1150.2404.02/.04	Message Monitor for CDMA2000
CMU-B99	1150.1250.02	RF1 Level Range identical to RF2
CMU-U61	1100.5500.02	Floppy Disk Drive
CMU-Z1	1100.7490.02	Memory Card

complies with the provisions of the Directive of the Council of the European Union on the approximation of the laws of the Member States

- relating to electrical equipment for use within defined voltage limits (73/23/EEC revised by 93/68/EEC)
- relating to electromagnetic compatibility (89/336/EEC revised by 91/263/EEC, 92/31/EEC, 93/68/EEC)

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ROHDE & SCHWARZ GmbH & Co. KG
Mühldorfstr. 15, D-81671 München
Central Quality Management FS-QZ / Becker

Munich, 2002-09-02

Support Center

Telefon / Telephone:	**+49 (0)180 512 42 42**
Fax:	**+49 89 41 29 137 77**
E-mail:	**CustomerSupport@rohde-schwarz.com**

Für technische Fragen zu diesem Rohde & Schwarz-Gerät steht Ihnen die Hotline der Rohde & Schwarz Vertriebs-GmbH, Support Center, zur Verfügung.

Unser Team bespricht mit Ihnen Ihre Fragen und sucht Lösungen für Ihre Probleme.

Die Hotline ist Montag bis Freitag von 8.00 bis 17.00 Uhr MEZ besetzt.

Bei Anfragen außerhalb der Geschäftszeiten hinterlassen Sie bitte eine Nachricht oder senden Sie eine Notiz per Fax oder E-Mail. Wir setzen uns dann baldmöglichst mit Ihnen in Verbindung.

Um Ihr Gerät stets auf dem neuesten Stand zu halten, abonnieren Sie bitte Ihren persönlichen Newsletter unter

http://www.rohde-schwarz.com/www/response.nsf/newsletterpreselection.

Sie erhalten dann regelmäßig Informationen über Rohde & Schwarz-Produkte Ihrer Wahl, über Firmware-Erweiterungen, neue Teiber und Applikationsschriften.

Should you have any technical questions concerning this Rohde & Schwarz product, please contact the hotline of Rohde & Schwarz Vertriebs-GmbH, Support Center.

Our hotline team will answer your questions and find solutions to your problems.

You can reach the hotline Monday through Friday from 8:00 until 17:00 CET.

If you need assistance outside office hours, please leave a message or send us a fax or e-mail. We will contact you as soon as possible.

To keep your instrument always up to date, please subscribe to your personal newsletter at

http://www.rohde-schwarz.com/www/response.nsf/newsletterpreselection.

As a subscriber, you will receive information about your selection of Rohde & Schwarz products, about firmware extensions, new drivers and application notes on a regular basis.

ROHDE&SCHWARZ

Adressen/Addresses

FIRMENSITZ/HEADQUARTERS

Phone
Fax
E-mail

Rohde & Schwarz GmbH & Co. KG +49 (89) 41 29-0
Mühldorfstraße 15 · D-81671 München +49 89 4129-121 64
Postfach 80 14 69 · D-81614 München info@rohde-schwarz.com

WERKE/PLANTS

Rohde & Schwarz Messgerätebau GmbH +49 (8331) 108-0
Riedbachstraße 58 · D-87700 Memmingen +49 (8331) 108-11 24
Postfach 1652 · D-87686 Memmingen info.rsmb@rohde-schwarz.com

Rohde & Schwarz GmbH & Co. KG +49 (9923) 857-0
Werk Teisnach +49 (9923) 857-11 74
Kaikenrieder Straße 27 · D-94244 Teisnach info.rsts@rohde-schwarz.com
Postfach 1149 · D-94240 Teisnach

Rohde & Schwarz GmbH & Co. KG +49 (2203) 49-0
Dienstleistungszentrum Köln +49 (2203) 49 51-308
Graf-Zeppelin-Straße 18 · D-51147 Köln info.rsdc@rohde-schwarz.com
Postfach 98 02 60 · D-51130 Köln service.rsdc@rohde-schwarz.com

TOCHTERUNTERNEHMEN/SUBSIDIARIES

Rohde & Schwarz Vertriebs-GmbH +49 (89) 41 29-137 74
Mühldorfstraße 15 · D-81671 München +49 (89) 41 29-137 77
Postfach 80 14 69 · D-81614 München

Rohde & Schwarz International GmbH +49 (89) 41 29-129 84
Mühldorfstraße 15 · D-81671 München +49 (89) 41 29-120 50
Postfach 80 14 60 · D-81614 München info.rsi@rohde-schwarz.com

Rohde & Schwarz Engineering and Sales GmbH +49 (89) 41 29-137 11
+49 (89) 41 29-137 23
Mühldorfstraße 15 · D-81671 München info.rse@rohde-schwarz.com
Postfach 80 14 29 · D-81614 München

Rohde & Schwarz BICK Mobilfunk GmbH +49 (5042) 998-0
Fritz-Hahne-Str. 7 · D-31848 Bad Münder +49 (5042) 998-105
Postfach 2062 · D-31844 Bad Münder info.bick@rohde-schwarz.com

Rohde & Schwarz FTK GmbH +49 (30) 658 91-122
Wendenschlossstraße 168, Haus 28 +49 (30) 655 50-221
D-12557 Berlin info.ftk@rohde-schwarz.com

Rohde & Schwarz SIT GmbH +49 (30) 658 84-0
Agastraße 3 +49 (30) 658 84-183
D-12489 Berlin info.sit@rohde-schwarz.com

ADRESSEN WELTWEIT/ADDRESSES WORLDWIDE

Albania siehe/see Austria

Algeria Rohde & Schwarz +213 (21) 48 20 18
Bureau d'Alger +213 (21) 69 46 08
5B Place de Laperrine
16035 Hydra-Alger

Argentina Precision Electronica S.R.L. +541 (14) 331 41 99
Av. Pde Julio A. Roca 710 - 6° Piso +541 (14) 334 51 11
(C1067ABP) Buenos Aires alberto_lombardi@prec-elec.com.ar

Australia Rohde & Schwarz (Australia) Pty. Ltd. +61 (2) 88 45 41 00
Sales Support +61 (2) 96 38 39 88
Unit 6 lyndell.james@rsaus.rohde-schwarz.com
2-8 South Street
Rydalmere, N.S.W. 2116

Austria Rohde & Schwarz-Österreich Ges.m.b.H. +43 (1) 602 61 41-0
Am Europlatz 3 +43 (1) 602 61 41-14
Gebäude B rs-austria@rsoe.rohde-schwarz.com
1120 Wien

Azerbaijan Rohde & Schwarz Azerbaijan +994 (12) 93 31 38
Liaison Office Baku +994 (12) 93 03 14
ISR Plaza rs-azerbaijan@rus.rohde-schwarz.com
340 Nizami Str.
370000 Baku

Baltic Countries siehe/see Denmark

Bangladesh BIL Consortium Ltd. +880 (2) 881 06 53
Corporate Office +880 (2) 882 82 91
House-33, Road-4, Block-F
Banani
Dhaka-1213

Belgium Rohde & Schwarz Belgium N.V. +32 (2) 721 50 02
Excelsiorlaan 31 Bus 1 +32 (2) 725 09 36
1930 Zaventem info@rsb.rohde-schwarz.com

Bosnia-Herzegovina siehe/see Slovenia

Brazil Rohde & Schwarz Do Brasil Ltda. +55 (11) 56 44 86 11 (general)
Av. Alfredo Egidio de Souza Aranha n° 177, +55 (11) 56 44 86 25 (sales)
1° andar - Santo Amaro +55 (11) 56 44 86 36
04726-170 Sao Paulo - SP sales-brazil@rsdb.rohde-schwarz.com

Brunei GKL Equipment Pte Ltd. +65 (6) 276 06 26
#11-01 BP Tower +65 (6) 276 06 29
396 Alexandra Road gkleqpt@singnet.com.sg
Singapore 119954

Bulgaria Rohde & Schwarz +359 (2) 96 343 34
Representation Office Bulgaria +359 (2) 96 321 97
39, Fridtjof Nansen Blvd. rs-bulgaria@rsbg.rohde-schwarz
1000 Sofia

Canada Rohde & Schwarz Canada Inc. +1 (613) 592 80 00
555 March Rd. +1 (613) 592 80 09
Kanata, Ontario K2K 2M5 cgirwarnauth@rscanada.ca

Tektronix Canada Inc. +1 (514) 331 43 34
Test and Measurement +1 (514) 331 59 91
4929 Place Olivia
Saint-Laurent, Pq
Montreal H4R 2V6

Chile Dymeq Ltda. +56 (2) 339 20 00
Av. Larrain 6666 +56 (2) 339 20 10
Santiago dymeq@dymeq.com

China Rohde & Schwarz China Ltd. +86 (10) 64 31 28 28
Representative Office Beijing +86 (10) 64 37 98 88
Room 602, Parkview Center info.rschina@rsbp.rohde-schwarz.com
2 Jiangtai Road
Chao Yang District
Beijing 100016

Rohde & Schwarz China Ltd. +86 (21) 63 75 00 18
Representative Office Shanghai +86 (21) 63 75 91 70
Central Plaza
227 Huangpi North Road
RM 807/809
Shanghai 200003

Rohde & Schwarz China Ltd. +86 (20) 87 55 47 58
Representative Office Guangzhou +86 (20) 87 55 47 59
Room 2903, Metro Plaza
183 Tianhe North Road
Guangzhou 510075

Rohde & Schwarz China Ltd. +86 (28) 86 52 76 05 to 09
Representative Office Chengdu +86 (28) 86 52 76 10
Unit G, 28/F, First City Plaza rsbpc@mail.sc.cninfo.net
308 Shuncheng Avenue
Chengdu 610017

Rohde & Schwarz China Ltd. +86 (29) 321 82 33
Representative Office Xi'an +86 (29) 329 60 15
Room 10125, Jianguo Hotel Xi'an sherry.yu@rsbp.rohde-schwarz.com
No. 2, Huzhu Road
Xi'an 710048

Adressen/Addresses

China
Rohde & Schwarz China Ltd.
Representative Office Shenzhen
No. 2002 Jiabin Road
Luohu District
Shenzhen 518001
+86 (755) 25 18 50 18
+86 (755) 25 18 50 18
jessica.lia@rsbp.rohde-schwarz.com

Croatia
siehe/see Slovenia

Cyprus
Hinis Telecast Ltd.
Agiou Thoma 18
Kiti
Larnaca 7550
+357 (24) 42 51 78
+357 (24) 42 46 21
hinis@logos.cy.net

Czech Republic
Rohde & Schwarz Praha s.r.o.
Hadovka Office Park
Evropska 33c
16000 Praha 6
+420 (2) 24 31 12 32
+420 (2) 24 31 70 43
office@rscz.rohde-schwarz.com

Denmark
Rohde & Schwarz Danmark A/S
Ejby Industrivej 40
2600 Glostrup
+45 (43) 43 66 99
+45 (43) 43 77 44

Ecuador
Representaciones Manfred Weinzierl
Via Lactea No. 4 y Via Sta. Ines
P.O.Box 17-22-20309
1722 Cumbaya Quito
+593 (22) 89 65 97
+593 (22) 89 65 97
mweinzierl@plus.net.ec

Egypt
U.A.S. Universal Advanced Systems
31 Manshiet El Bakry Street
Heliopolis
11341 Cairo
+20 (2) 455 67 44
+20 (2) 256 17 40
an_uas@link.net

El Salvador
siehe/see Mexico

Estonia
Rohde & Schwarz Danmark A/S
Estonian Branch Office
Narva mnt. 13
10151 Tallinn
+372 (6) 14 31 23
+372 (6) 14 31 21
margo.fingling@rsdk.rohde-schwarz.com

Finland
Orbis Oy
P.O.Box 15
00421 Helsinki 42
+358 (9) 47 88 30
+358 (9) 53 16 04
info@orbis.fi

France
Rohde & Schwarz France
Immeuble "Le Newton"
9-11, rue Jeanne Braconnier
92366 Meudon La Forêt Cedex
+33 (1) 41 36 10 00
+33 (1) 41 36 11 73
contact@rsf.rohde-schwarz.com

Niederlassung/Subsidiary Rennes
37 Rue du Bignon
Bât. A
F-35510 Cesson Sevigne
+33 (0) 299 51 97 00
+33 (0) 299 51 98 77

Niederlassung/Subsidiary Toulouse
Technoparc 3
B.P. 501
F-31674 Labege Cédex
+33 (0) 561 39 10 69
+33 (0) 561 39 99 10

Office Aix-en-Provence
+33 (0) 494 07 39 94
+33 (0) 494 07 55 11

Office Lyon
+33 (0) 478 29 88 10
+33 (0) 478 79 18 57

Office Nancy
+33 (0) 383 54 51 29
+33 (0) 383 54 82 09

Germany
Zweigniederlassungen der Rohde & Schwarz Vertriebs-GmbH/Branch offices of Rohde & Schwarz Vertriebs-GmbH

Zweigniederlassung Nord, Geschäftsstelle Berlin
Ernst-Reuter-Platz 10 · D-10587 Berlin
Postfach 100620 · D-10566 Berlin
+49 (30) 34 79 48-0
+49 (30) 34 79 48 48
info.rsv@rohde-schwarz.com

Germany
Zweigniederlassung Büro Bonn
Josef-Wirmer-Straße 1-3 · D-53123 Bonn
Postfach 140264 · D-53057 Bonn
+49 (228) 918 90-0
+49 (228) 25 50 87
info.rsv@rohde-schwarz.com

Zweigniederlassung Nord, Geschäftsstelle Hamburg
Steilshooper Alle 47 · D-22309 Hamburg
Postfach 60 22 40 · D-22232 Hamburg
+49 (40) 63 29 00-0
+49 (40) 630 78 70
info.rsv@rohde-schwarz.com

Zweigniederlassung Mitte, Geschäftsstelle Köln
Niederkasseler Straße 33 · D-51147 Köln
Postfach 900 149 · D-51111 Köln
+49 (2203) 807-0
+49 (2203) 807 650
info.rsv@rohde-schwarz.com

Zweigniederlassung Süd, Geschäftsstelle München
Mühldorfstraße 15 · D-81671 München
Postfach 80 14 69 · D-81614 München
+49 (89) 41 86 95-0
+49 (89) 40 47 64
info.rsv@rohde-schwarz.com

Zweigniederlassung Süd, Geschäftsstelle Nürnberg
Donaustraße 36
D-90451 Nürnberg
+49 (911) 642 03-0
+49 (911) 642 03-33
info.rsv@rohde-schwarz.com

Zweigniederlassung Mitte, Geschäftsstelle Neu-Isenburg
Siemensstraße 20
D-63263 Neu-Isenburg
+49 (6102) 20 07-0
+49 (6102) 20 07 12
info.rsv@rohde-schwarz.com

Ghana
Kop Engineering Ltd.
P.O. Box 11012
3rd Floor Akai House, Osu
Accra North
+233 (21) 77 89 13
+233 (21) 701 06 20

Greece
Mercury S.A.
6, Loukianou Str.
10675 Athens
+302 (10) 722 92 13
+302 (10) 721 51 98
mercury@hol.gr

Guatemala
siehe/see Mexico

Honduras
siehe/see Mexico

Hong Kong
Electronic Scientific Engineering
9/F North Somerset House
Taikoo Place
979 King's Road
Hong Kong
+852 (25) 07 03 33
+852 (25) 07 09 25
stephenchau@ese.com.hk

Hungary
Rohde & Schwarz
Budapesti Iroda
Váci út 169
1138 Budapest
+36 (1) 412 44 60
+36 (1) 412 44 61
rs-hungary@rshu.rohde-schwarz.com

Iceland
siehe/see Denmark

India
Rohde & Schwarz India Pvt. Ltd.
Bangalore Office
No. 24, Service Road, Domlur
2nd Stage Extension
Bangalore - 560 071
+91 (80) 535 23 62
+91 (80) 535 03 61
rsindiab@rsnl.net

India
Rohde & Schwarz India Pvt. Ltd.
Hyderabad Office
302 & 303, Millenium Centre
6-3-1099/1100, Somajiguda
Hyderabad - 500 016
+91 (40) 23 32 24 16
+91 (40) 23 32 27 32
rsindiah@nd2.dot.net.in

India
Rohde & Schwarz India Pvt. Ltd.
RS India Mumbai Office
B-603, Remi Bizcourt, Shah Industrial Estate, Off Veera Desai Road
Mumbai - 400 058
+91 (22) 26 30 18 10
+91 (22) 26 73 20 81
rsindiam@rsnl.net

Indonesia
PT Rohde & Schwarz Indonesia
Graha Paramita 5th Floor
Jln. Denpasar Raya Blok D-2
Jakarta 12940
+62 (21) 252 36 08
+62 (21) 252 36 07
sales@rsbj.rohde-schwarz.com
services@rsbj.rohde-schwarz.com

Adressen/Addresses

Iran
Rohde & Schwarz Iran
Groundfloor No. 1, 14th Street
Khaled Eslamboli (Vozara) Ave.
15117 Tehran
+98 (21) 872 42 96
+98 (21) 871 90 12
rs-tehran@neda.net

Ireland
siehe/see United Kingdom

Israel
Eastronics Ltd.
Messtechnik/T&M Equipment
11 Rozanis St.
P.O.Box 39300
Tel Aviv 61392
+972 (3) 645 87 77
+972 (3) 645 86 66
david_hasky@easx.co.il

J.M. Moss (Engineering) Ltd.
Kommunikationstechnik/ Communications Equipment
9 Oded Street
P.O.Box 967
52109 Ramat Gan
+972 (3) 631 20 57
+972 (3) 631 40 58
jmmoss@zahav.net.il

Italy
Rohde & Schwarz Italia S.p.a.
Centro Direzionale Lombardo
Via Roma 108
20060 Cassina de Pecchi (MI)
+39 (02) 95 70 42 03
+39 (02) 95 30 27 72
ornella.crippa@rsi.rohde-schwarz.com

Rohde & Schwarz Italia S.p.a.
Via Tiburtina 1182
00156 Roma
+39 (06) 41 59 82 18
+39 (06) 41 59 82 70

Japan
Rohde & Schwarz
Support Center Japan K.K.
711 bldg., Room 501 (5th floor)
7-11-18 Nishi-Shinjuku
Shinjuku-ku
Tokyo 160-0023
+81 (3) 59 25 12 88
+81 (3) 59 25 12 90

Advantest Corp.
Sales Promotion Department
Shinjuku-NS bldg.
2-4-1, Nishi-Shinjuku
Shinjuku-ku
Tokyo 160-0880
+81 (3) 33 42 75 52
+81 (3) 53 22 72 70
mkoyama@ns.advantest.co.jp

Jordan
Jordan Crown Engineering & Trading Co.
Jabal Amman, Second Circle
Youssef Ezzideen Street
P.O.Box 830414
Amman, 11183
+962 (6) 462 17 29
+962 (6) 465 96 72
jocrown@go.com.jo

Kazakhstan
Rohde & Schwarz Kazakhstan
Representative Office Almaty
Pl. Respubliki 15
480013 Almaty
+7 (32) 72 67 23 54
+7 (32) 72 67 23 46
rs-kazakhstan@rus-rohde-schwarz.com

Kenya
Excel Enterprises Ltd
Dunga Road
P.O.Box 42 788
Nairobi
+254 (2) 55 80 88
+254 (2) 54 46 79

Korea
Rohde & Schwarz Korea Ltd.
83-29 Nonhyun-Dong, Kangnam-Ku
Seoul 135-010
+82 (2) 3485 1900
+82 (2) 3485 1900
sales@rskor.rohde-schwarz.com
service@rskor.rohde-schwarz.com

Kuwait
Group Five Trading & Contracting Co.
Mezanine Floor
Al-Bana Towers
Ahmad Al Jaber Street
Sharq
+965 (244) 91 72/73/74
+965 (244) 95 28
jk_agarwal@yahoo.com

Latvia
Rohde & Schwarz Danmark A/S
Latvian Branch Office
Merkela iela 21-301
1050 Riga
+371 (7) 50 23 55
+371 (7) 50 23 60
rsdk@rsdk.rohde-schwarz.com

Lebanon
Rohde & Schwarz
Liaison Office Riyadh
P.O.Box 361
Riyadh 11411
+966 (1) 465 64 28 Ext. 303
+966 (1) 465 64 28 Ext. 229
chris.porzky@rsd.rohde-schwarz.com

Lebanon
Netcom
P.O.Box 55199
Op. Ex-Presidential Palace
Horsh Tabet
Beirut
+961-1-48 69 99
+961-1-49 05 11
netcom@inco.com.lb

Liechtenstein
siehe/see Switzerland

Lithuania
Rohde & Schwarz Danmark A/S
Lithuanian Office
Lukiskiu 5-228
2600 Vilnius
+370 (5) 239 50 10
+370 (5) 239 50 11

Luxembourg
siehe/see Belgium

Macedonia
siehe/see Slovenia

Malaysia
Dagang Teknik Sdn. Bhd.
No. 9, Jalan SS 4D/2
Selangor Darul Ehsan
47301 Petaling Jaya
+60 (3) 27 03 55 68
+60 (3) 27 03 34 39
maryanne@danik.com.my

Malta
ITEC International Technology Ltd
B'Kara Road
San Gwann SGN 08
+356 (21) 37 43 00 or 37 43 29
+356 (21) 37 43 53
sales@itec.com.mt

Mexico
Rohde & Schwarz de Mexico
Av. Prol. Americas No. 1600, 2° Piso
Col. Country Club
Guadalajara, Jal.
Mexico CP, 44610
+52 (33) 36 78 91 70
+52 (33) 36 78 92 00

Rohde & Schwarz de Mexico
S. de R.L. de C.V.
German Centre Oficina 4-2-2
Av. Santa Fé 170
Col. Lomas de Santa Fé
01210 Mexico D.F.
+52 (55) 85 03 99 13
+52 (55) 85 03 99 16
latinoamerica@rsd.rohde-schwarz.com

Moldavia
siehe/see Romania

Nepal
ICTC Pvt. Ltd.
Hattisar, Post Box No. 660
Kathmandu
+977 (1) 443 48 95
+977 (1) 443 49 37
ictc@mos.com.np

Netherlands
Rohde & Schwarz Nederland B.V.
Perkinsbaan 1
3439 ND Nieuwegein
+31 (30) 600 17 00
+31 (30) 600 17 99
info@rsn.rohde-schwarz.com

New Zealand
Nichecom
1 Lincoln Ave.
Tawa, Wellington
+64 (4) 232 32 33
+64 (4) 232 32 30
rob@nichecom.co.nz

Nicaragua
siehe/see Mexico

Nigeria
Ferrostaal Abuja
Plot 3323, Barada Close
P.O.Box 8513, Wuse
Off Amazon Street
Maitama, Abuja
+234 (9) 413 52 51
+234 (9) 413 52 50
fsabuja@rosecom.net

Norway
Rohde & Schwarz Norge AS
Enebakkveien 302 B
1188 Oslo
+47 (23) 38 66 00
+47 (23) 38 66 01

Oman
Mustafa Sultan Science & Industry Co.LLC.
Test & Measurement Products
Way No. 3503
Building No. 241
Postal Code 112
Al Khuwair, Muscat
+968 63 60 00
+968 60 70 66
m-aziz@mustafasultan.com

Pakistan
Siemens Pakistan
23, West Jinnah Avenue
Islamabad
+92 (51) 227 22 00
+92 (51) 227 54 98
reza.bokhary@siemens.com.pk

Adressen/Addresses

Panama	siehe/see Mexico	
Papua New Guinea	siehe/see Australia	
Philippines	Rohde & Schwarz (Philippines) Ltd. PBCom Tower Ayala Ave cor Herrera Sts. Makati City	+63 (2) 755 88 70 +63 (2) 755 88 67
Poland	Rohde & Schwarz SP z o o. Przedstawicielstwo w Polsce ul Stawki 2, Pietro 28 00 193 Warszawa	+48 (22) 860 64 94 +48 (22) 860 64 99 rs-poland@rspl rohde-schwarz com
Portugal	Rohde & Schwarz Portugal, Lda Alameda Antonio Sergio 7-R/C - Sala A 2795-023 Linda-a-Velha	+351 (21) 415 57 00 +351 (21) 415 57 10 info@rspt rohde-schwarz com
Romania	Rohde & Schwarz Representation Office Bucharest Str Uranus 98 Sc 2, Et 5, Ap 36 76102 Bucuresti, Sector 5	+40 (21) 410 68 46 +40 (21) 411 20 13 rs-romania@rsro rohde-schwarz com
Russian Federation	Rohde & Schwarz Representative Office Moscow 119180, Yakimanskaya nab , 2 Moscow	+7 (095) 745 88 50 to 53 +7 (095) 745 88 54 rs-russia@rsru rohde-schwarz com
Saudi Arabia	Rohde & Schwarz Liaison Office Riyadh c/o Haji Abdullah Alireza Co Ltd P O Box 361 Riyadh 11411	+966 (1) 465 64 28 Ext 303 +966 (1) 465 6428 Ext 229 chris porzky@rsd rohde schwarz com
Saudi Arabia	Gentec Haji Abdullah Alireza & Co Ltd P O Box 43054 Riyadh	+966 (1) 465 64 28 +966 (1) 465-64 28 akanbar@gentec com sa
Serbia-Montenegro	Representative Office Belgrade Tose Jovanovica 7 11030 Beograd	+381 (11) 305 50 25 +381 (11) 305 50 24
Singapore	Rohde & Schwarz Regional Headquarters Singapore Pte Ltd 1 Kaki Bukit View #05-01/02 Techview Singapore 415 941	+65 (6) 846 1872 +65 (6) 846 1252 rsca@rssg.rohde-schwarz com
Slovak Republic	Specialne systemy a software, a.s. Svrcia ul 841 04 Bratislava	+421 (2) 65 42 24 88 +421 (2) 65 42 07 68 stefan.lozek@special.sk
Slovenia	Rohde & Schwarz Representation Ljubljana Tbilisijska 89 1000 Ljubljana	+386 (1) 423 46 51 +386 (1) 423 46 11 rs-slovenia@rssi rohde-schwarz.com
South Africa	Protea Data Systems (Pty.) Ltd. Communications and Measurement Division Private Bag X19 Bramley 2018	+27 (11) 719 57 00 +27 (11) 786 58 91 unicm@protea.co.za
South Africa	Protea Data Systems (Pty.) Ltd. Cape Town Branch Unit G9, Centurion Business Park Bosmandam Road Milnerton Cape Town, 7441	+27 (21) 555 36 32 +27 (21) 555 42 67 unicm@protea.co.za
Spain	Rohde & Schwarz Espana S.A. Salcedo, 11 28034 Madrid	+34 (91) 334 10 70 +34 (91) 329 05 06 rses@rses.rohde-schwarz.com

Sri Lanka	Dynatel Communications (PTE) Ltd. 451/A Kandy Road Kelaniya	+94 (1) 90 80 01 +94 (1) 91 04 69 dyna-svc@sltnet.lk
Sudan	SolarMan Co Ltd. P.O Box 11 545 North of Fraouq Cementry 6/7/9 Bldg 16 Karthoum	+249 (11) 47 31 08 +249 (11) 47 31 38 solarman29@hotmail com
Sweden	Rohde & Schwarz Sverige AB Marketing Div. Flygfältsgatan 15 128 30 Skarpnack	+46 (8) 605 19 00 +46 (8) 605 19 80 info@rss.se
Switzerland	Roschi Rohde & Schwarz AG Muhlestr 7 3063 Ittigen	+41 (31) 922 15 22 +41 (31) 921 81 01 sales@roschi rohde-schwarz com
Syria	Electro Scientific Office Baghdad Street Dawara Clinical Lab Bldg P O Box 8162 Damascus	+963 (11) 231 59 74 +963 (11) 231 88 75 memo@hamshointl.com
Taiwan	Rohde & Schwarz Taiwan (Pvt) Ltd. Floor 14, No 13, Sec 2, Pei-Tou Road Taipei 112	+886 (2) 28 93 10 88 +886 (2) 28 91 72 60 celine tu@rstw rohde-schwarz com
Tanzania	SSTL Group P O Box 7512 Dunga Street Plot 343/345 Dar es Salaam	+255 (22) 276 00 37 +255 (22) 276 02 93 sstl@ud.co tz
Thailand	Schmidt Electronics (Thailand) Ltd. 63 Government Housing Bank Bldg Tower II, 19th floor, Rama 9 Rd Huaykwang, Bangkapi Bangkok 10320	+66 (2) 643 13 30 to 39 +66 (2) 643 13 40 kamthoninthuyot@schmidtthailand com
Trinidad &Tobago	siehe/see Mexico	
Tunisia	Teletek 71, Rue Alain Savary Residence Alain Savary (C64) 1003 Tunis	+216 (71) 77 22 88 +216 (71) 77 05 53
Turkey	Rohde & Schwarz International GmbH Liaison Office Istanbul Bagdad Cad 191/3, Arda Apt. B-Blok 81030 Selamicesme-Istanbul	+90 (216) 385 19 17 +90 (216) 385 19 18 rsturk@superonline.com
Ukraine	Rohde & Schwarz Representative Office Kiev 4, Patris Loumoumba ul 01042 Kiev	+38 (044) 268 60 55 +38 (044) 268 83 64 rsbkiev@public.ua.net
United Arab Emirates	Rohde & Schwarz International GmbH Liaison Office Abu Dhabi P.O Box 31156 Abu Dhabi	+971 50 62 40 197 +971 (4) 3944 794 michael.rogler@rsd.rohde-schwarz.com
United Arab Emirates	Rohde & Schwarz Bick Mobile Communication P O Box 17466 Dubai	+971 (4) 883 71 35 +971 (4) 883 71 36
United Arab Emirates	Rohde & Schwarz Emirates L.L.C. Ahmed Al Nasri Building, Mezzanine Floor, P.O.Box 31156 Off old Airport Road Behind new GEMACO Furniture Abu Dhabi	+971 (2) 631 20 40 +971 (2) 631 30 40 rsuaeam@emirates.net.ae

Adressen/Addresses

United Kingdom	Rohde & Schwarz UK Ltd. Ancells Business Park Fleet Hampshire GU 51 2UZ England	+44 (1252) 81 88 88 (sales) +44 (1252) 81 88 18 (service) +44 (1252) 81 14 47 sales@rsuk.rohde-schwarz.com
Uruguay	Aeromarine S.A. Cerro Largo 1497 11200 Montevideo	+598 (2) 400 39 62 +598 (2) 401 85 97 mjn@aeromarine.com.uy
USA	Rohde & Schwarz, Inc. Broadcast & Comm. Equipment 8661-A Robert Fulton Drive Columbia, MD 21046-2265	+1 (410) 910 78 00 +1 (410) 910 78 01 rsatv@rsa.rohde-schwarz.com rsacomms@rsa.rohde-schwarz.com
USA	Rohde & Schwarz, Inc. Marketing & Support Center/T&M Equipment 2540 SW Alan Blumlein Way M/S 58-925 Beaverton, OR 97077-0001	+1 (503) 627 26 84 +1 (503) 627 25 65 info@rsa.rohde-schwarz.com
USA	Rohde & Schwarz, Inc. Systems & EMI Products 8080 Tristar Drive Suite 120 Irving, Texas 75063	+1 (469) 713 53 00 +1 (469) 713 53 01 info@rsa.rohde-schwarz.com
Venezuela	Equilab Telecom C.A. Centro Seguros La Paz Piso 6, Local E-61 Ava. Francisco de Miranda Boleita, Caracas 1070	+58 (2) 12 34 46 26 +58 (2) 122 39 52 05 r_ramirez@equilabtelecom.com
Venezuela	Representaciones Bopic S.A. Calle C-4 Qta. San Jose Urb. Caurimare Caracas 1061	+58 (2) 129 85 21 29 +58 (2) 129 85 39 94 incotr@cantv.net
Vietnam	Schmidt Vietnam Co. (H.K.) Ltd., Representative Office Hanoi Intern. Technology Centre 8/F, HITC Building 239 Xuan Thuy Road Cau Giay, Tu Liem Hanoi	+84 (4) 834 61 86 +84 (4) 834 61 88 svnhn@schmidtgroup.com
West Indies	siehe/see Mexico	

Contents of Manuals for Universal Radio Communication Tester CMU

The user documentation for the R&S CMU 200/300 is divided in this operating manual for the basic instrument (including options CMU-B41, CMU-B17) and separate manuals for individual software and hardware options. The complete documentation is available on CD-ROM, stock no. PD 0757.7746.2x. The latest revisions of all manuals are also posted on the CMU Customer Web on GLORIS.

Operating Manual CMU200/CMU300

The present operating manual contains comprehensive information about the technical data of the instrument, its setup and putting into operation, the operating concept and controls as well as the operation of the CMU via the menus of the graphical user interface and via remote control. Typical measurement tasks for the CMU are explained in detail using the functions on the graphical user interface and a selection of program examples.

The manual is subdivided into the data sheet plus 10 chapters:

The data sheet	Informs about guaranteed specifications and characteristics of the instrument.
Chapter 1	Describes the control elements and connectors on the front and rear panel as well as all procedures required for putting the instrument into operation and integrating it into a test setup.
Chapter 2	Gives an introduction to typical measurement tasks of the CMU which are explained step by step.
Chapter 3	Describes key operating modes, the structure of the graphical interface and the principles of measurement control.
Chapter 4	Forms a reference for manual control of the CMU and contains a detailed description of all instrument functions belonging to function groups *Base* and *RF Non Signalling.* All software options that come without a separate operating manual are also described at the end of chapter 4. The chapter lists the remote control command for each instrument function.
Chapter 5	Describes the basics for programming the CMU, command processing and the status reporting system.
Chapter 6	Lists all the remote-control commands of the function groups and options reported in chapter 4. At the end of the chapter the commands are listed by their function and in alphabetical order.
Chapter 7	Contains program examples for a number of typical CMU applications.
Chapter 8	Describes preventive maintenance and the characteristics of the instrument's hardware interfaces.
Chapter 9	Gives a list of error messages that the CMU may generate.
Chapter 10	Contains an index for the operating manual.

Service Manual Instrument

The service manual instrument informs on how to check compliance with rated specifications, on instrument function, repair, troubleshooting and fault elimination. It contains all information required for the maintenance of CMU by exchanging modules.

Service Manual Modules

The service manual modules is not delivered with the instrument but may be obtained from your R&S service department using the order number 1100.4903.91.

Service manual modules contains information about the individual modules of CMU. This comprises the test and adjustment of the modules, fault detection within the modules and the interface description.

Operating Manuals for Digital and Analog Network Tests

The operating manuals listed in the following table describe the test of mobile phones supporting different standards by means of the CMU200/CMU300 and the appropriate software and hardware options. Except for hardware-specific chapters that are not relevant to the software options, the network test operating manuals are organized like the present CMU operating manual.

		For Options		
Manual	**Order Number**	**Type**	**Description**	**Stock No.**
Operating Manual CMU-K20/-K21/-K22/-K23/-K24	1115.6088.12	CMU-K20 CMU-K21 CMU-K22 CMU-K23 CMU-K24 CMU-K42 CMU-K43 CMU-K45	GSM400-MS for CMU-B21 GSM900-MS for CMU-B21 GSM1800-MS for CMU-B21 GSM1900-MS for CMU-B21 GSM850-MS for CMU-B21 GPRS software extension for GSM EGPRS software extension for GSM AMR GSM for CMU200	1115.5900.02 1115.6007.02 1115.6107.02 1115.6207.02 1115.6307.02 1115.4691.02 1115.6907.02 1150.3100.02
Operating Manual CMU-K27/-K28	1115.6688.12	CMU-K27 CMU-K28	TDMA800-MS for CMU-B21 TDMA1900-MS for CMU-B21	1115.6607.02 1115.6707.02
Operating Manual CMU-K29	1115.6888.12	CMU-K29	AMPS-MS for CMU-B21	1115.6807.02
Operating Manual CMU-K30/-K31/-K32/-K33	1115.4185.12	CMU-K30 CMU-K31 CMU-K32 CMU-K33 CMU-K39 CMU-K41	GSM400-BS for CMU-B21 GSM900-BS for CMU-B21 GSM1800-BS for CMU-B21 GSM1900-BS for CMU-B21 MOC/MTC EDGE for CMU-K30/31/32/33	1115.4004.02 1115.4104.02 1115.4104.02 1115.4104.02 1115.4791.02 1115.4604.02
Operating Manual CMU-K53	1115.5081.12	CMU-K53	Bluetooth for CMU	1115.5000.02
Operating Manual CMU-K65/…/-K69	1115.4962.12	CMU-K65 CMU-K66 CMU-K67 CMU-K68 CMU-K69	WCDMA UE TX Test (3GPP/FDD) WCDMA UE DL Generator WCDMA UE Band III Signalling WCDMA UE Band I Signalling WCDMA UE Band II Signalling	1115.4891.02 1115.5100.02 1150.3000.02 1115.5300.02 1115.5400.02
Operating Manual CMU-K75/-K76	1150.3398.12	CMU-K75 CMU-K76	WCDMA Node B TX Tests WCDMA Generator (3GPP/FDD, Release 99, Uplink)	1150.3200.02 1150.3300.02
Operating Manual CMU-K81/-K82	1115.5581.12	CMU-K81 CMU-K82	CDMA800-MS (IS95) for CMU-B81 CDMA1900-MS (IS95) for CMU-B81	1115.5500.02 1115.5600.02
Operating Manual CMU-K83/-K84/-K85/-K86	1150.0382.12	CMU-K83 CMU-K84 CMU-K85 CMU-K86	CDMA2000-MS (450 MHz band) CDMA2000-MS (cellular band) CDMA2000-MS (PCS band) CDMA2000-MS (IMT-2000 band)	1150.3500.02 1150.3600.02 1150.3700.02 1150.3800.02

The GSM base station tests described in operating manual CMU-K30/-K31/-K32/-K33/-K34 and the WCDMA UL generator described in operating manual CMU-K75/-K76 require a CMU300 (Universal Radio Communication Tester for BTS). Bluetooth tests are performed with model CMU200, var. 53. All other radio communication equipment is tested with model CMU200, var.02.

What's new in this Revision...

This operating manual describes version V3.40 of the CMU base software including *RF* and *Audio* measurements and the IQ-IF interface. Compared to previous versions, this new firmware provides numerous extensions and improvements. The most important new features described in this manual are listed below.

New Features	**Description**	**Refer to...**
RF User Correction	Correction of a frequency and level response in the test setup by means of interpolation tables.	Chapter 1, → RF User Correction
RF Aux Tx	Second, configurable RF signal in function group RF (with option CMU-B95, Additional RF Generator).	Chapter 4, RF Measurements → Generator Settings
Extended selftests	Selftests for new hardware components and generators added	Chapter 4, → Maintenance
*GTL	Device-specific *Go to Local* command, also works with serial interface	Chapter 5, → Return to Manual Operation
Extended status reporting system	Invalid measurement results cause bit no. 4 of the STATus:OPERation register to be set.	Chapter 5, → STATus:OPERation Register
Higher data rates	The serial interface supports data rates up to 115200 baud.	Chapter 4, → Serial Interfaces

Frequently Used Abbreviations

Att.	*Attenuation*
Cnt	*Center*
Ext.	*External*
Freq.	*Frequency*
GPIB	*General Purpose Interface Bus = IEEE Bus according to standard IEC 625.1/IEEE 488.1*
IF	*Intermediate Frequency*
Max.	*Maximum (Level)*
Pk	*Peak*
RBW	*Resolution Bandwidth*
Ref.	*Reference*
Rel.	*Relative*
RF	*Radio Frequency*
SSB	*Single Side Band*
SW	*Software*

Supplement to the Operating Manual
for Universal Radio Communication Tester
R&S CMU 200

Addendum to the data sheet, no. 757.4318.25 (1001)

With CMU-U99/-B99 installed, the input/output level range and the input/output level uncertainty for RF1 is the same as for RF2. With CMU-U99/-B99 installed, the VSWR of the RF generator and analyzer at RF1 is as follows:

VSWR at RF1 connector (RF generator and RF analyzer)	**page 34**
10 MHz to 2000 MHz	<1.2
2000 MHz to 2200 MHz	**<1.4**
2200 MHz to 2700 MHz	<1.6

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1 Preparation for Use 1.1

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Rear View 1.8

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- Setting up the Instrument 1.10
- Mounting in a Rack 1.11
- Connecting the Instrument to the AC Supply 1.11
- Switching on the Instrument / Startup Test 1.11
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- How to Ensure EMC 1.13
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Connecting the CMU to the Test Setup 1.14
- Connecting a Controller 1.14
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- Connecting a Monitor 1.16
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RF User Correction 1.27
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- Ranges of Values and Limitations 1.30
- Interpolation Rules 1.31

1 Preparation for Use

This chapter describes the controls and connectors of the Universal Radio Communication Tester CMU and gives all information that is necessary to put the instrument into operation and connect external devices. Notes on reinstallation of the CMU software and a description of the *VersionManager* terminate this chapter.

Caution!

Please make sure to observe the instructions of the following sections in order not to cause damage to the instrument or endanger people. This is of particular importance when the instrument is used for the first time. Also observe the general safety instructions at the beginning of this manual.

A more detailed description of the hardware connectors and interfaces can be found in chapter 8. Chapter 2 provides an introduction to the operation of the CMU by means of typical examples of configuration and measurement; for a description of the operating concept refer to chapter 3.

For remote control of the CMU refer to the general description of the SCPI commands, the instrument model, the status reporting system and measurement control in chapter 5.

Front and Rear View

The front panel of the CMU consists of the VGA display with the softkey area (left side) and the hardkey area (right side, see Fig. 1-1). Brief explanations on the controls and connectors of the hardkey area and the rear panel are to be found on the next pages. Operation by means of softkeys is described in chapter 3, *Manual Operation*.

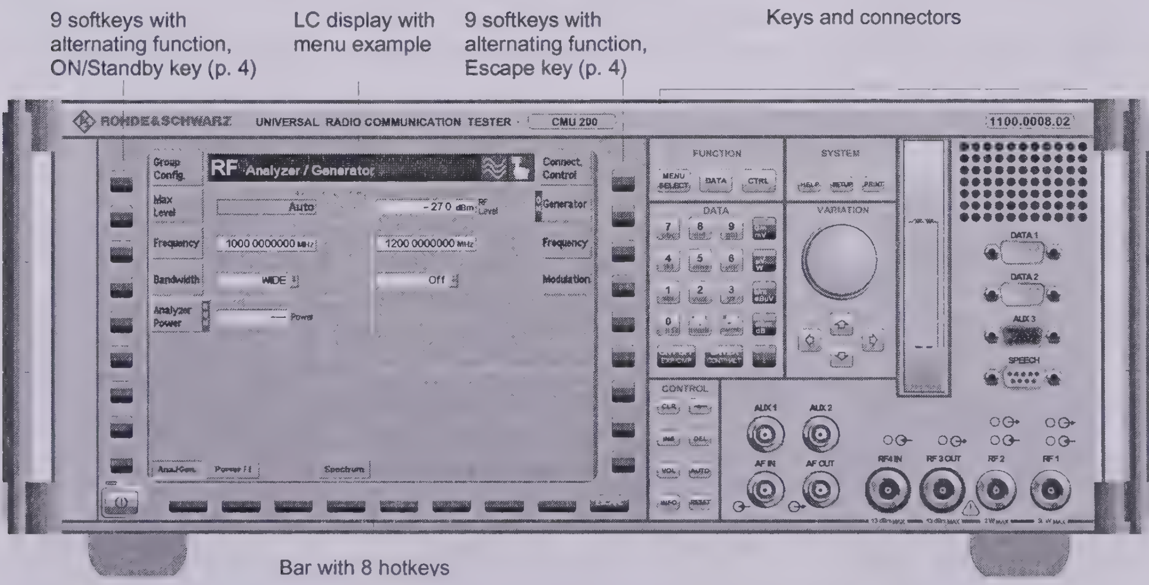
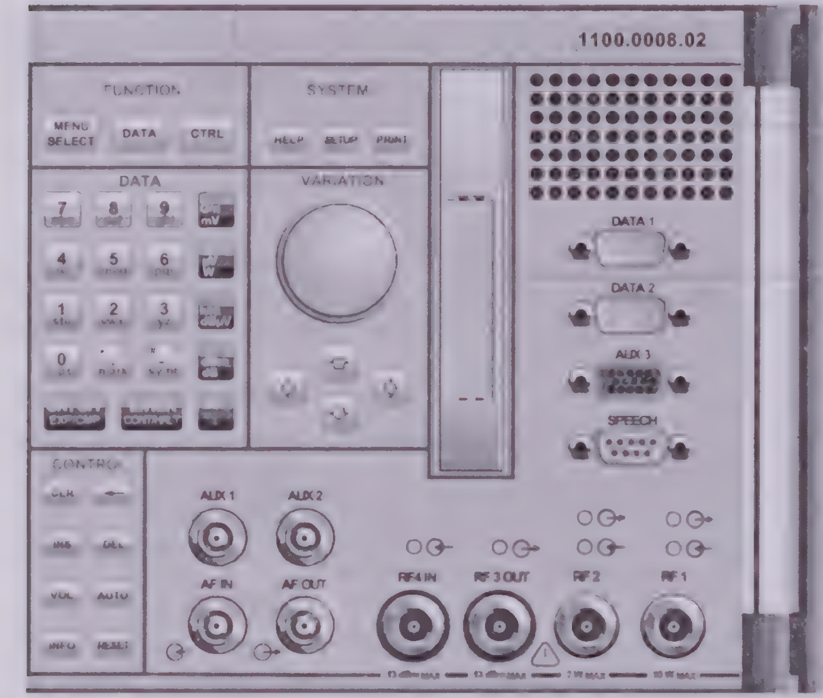

9 softkeys with alternating function, ON/Standby key (p. 4)
LC display with menu example
9 softkeys with alternating function, Escape key (p. 4)
Keys and connectors
ROHDE&SCHWARZ UNIVERSAL RADIO COMMUNICATION TESTER · CMU 200
1100.0008.02
RF Analyzer / Generator
FUNCTION
SYSTEM
DATA
VARIATION
CONTROL
DATA 1
DATA 2
AUX 3
SPEECH
AUX 1
AUX 2
AF IN
AF OUT
RF4 IN
RF 3 OUT
RF 2
RF 1
Bar with 8 hotkeys

Fig. 1-1 CMU front view

Data input Selection of the most important CMU functions via menus


1100.0008.02
FUNCTION
MENU SELECT
DATA
CTRL
SYSTEM
HELP
SETUP
PRINT
DATA
VARIATION
DATA 1
DATA 2
AUX 3
SPEECH
CONTROL
CLR
INS
DEL
VOL
AUTO
INFO
RESET
AUX 1
AUX 2
AF IN
AF OUT
RF4 IN
RF 3 OUT
RF 2
RF 1

Loudspeaker, for future extensions

PCMCIA interface

as an alternative: Floppy disk drive (option CMU-U61)

Fig. 1-2 CMU front view – hardkeys

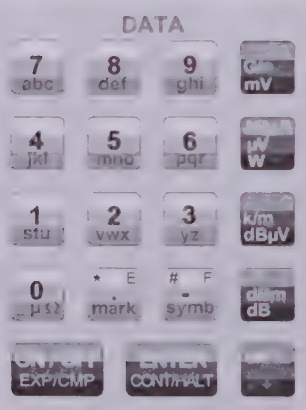
FUNCTION

FUNCTION
MENU SELECT
DATA
CTRL

Preselection of the menus:

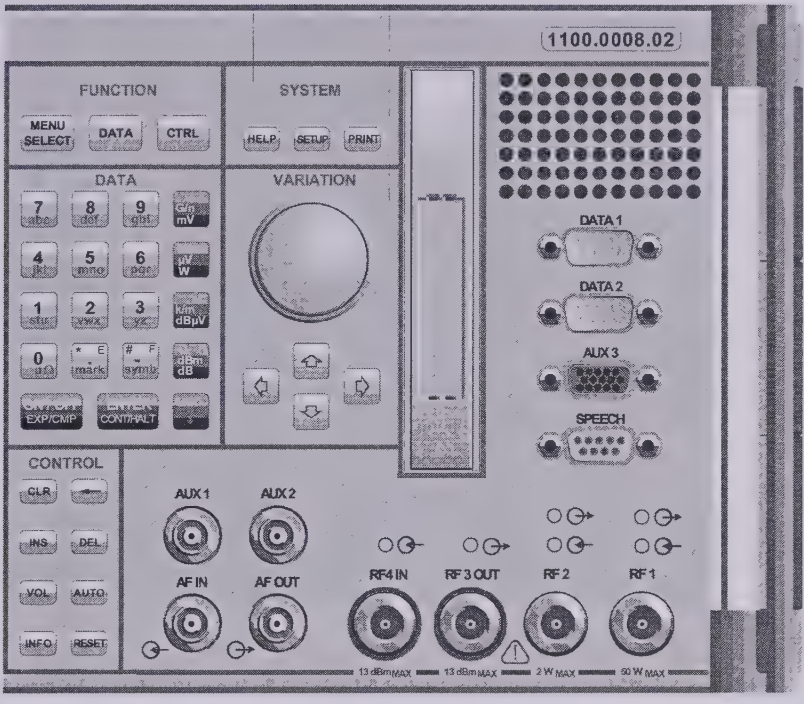
MENU SELECT	Menu selection	☞ Chap. 3
DATA	File manager	Chap. 4
CTRL	For future extensions	

DATA


DATA
7 abc
8 def
9 ghi
G/n mV
4 jkl
5 mno
6 pqr
M/µ µV W
1 stu
2 vwx
3 yz
k/m dBµV
0 µ Ω
* . E mark
# - F symb
dBm dB
ON/OFF EXP/CMP
ENTER CONT/HALT
UNIT

Data input:

0 ... 9	Numerical input (letters for string editors)	☞ Chap. 3
** . E*	Special characters, dec. point, hex value "E"	
# - F	Spec. characters, sign change, hex value "F"	
G/n mV A	Factor $10^9/10^{-9}$, unit, hex value "A"	
M/µ µV W	Factor $10^6/10^{-6}$, unit, hex value "B"	
k/m dB µV	Factor $10^3/10^{-3}$, unit, hex value "C"	
**1 dBm dB*	Factor 10^0, unit, hex value "D"	
ON / OFF *EXP/COMP*	Switching on/off editors/measurements	
ENTER	Confirmation of entry in editors	
CONT/HALT	Calling/quitting editors, measurement control	
UNIT ⇩	For future extensions	

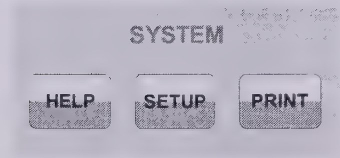

System control

Variation of numeric values and group selection in popup menus

1100.0008.02
FUNCTION
MENU SELECT
DATA
CTRL
SYSTEM
HELP
SETUP
PRINT
DATA
7 abc
8 def
9 ghi
G/n mV
4 jkl
5 mno
6 pqr
µV W
1 stu
2 vwx
3 yz
k/m dBµV
0
mark
symb
dBm dB
EXP/CMP
CONT/HALT
VARIATION
CONTROL
CLR
INS
DEL
VOL
AUTO
INFO
RESET
AUX 1
AUX 2
AF IN
AF OUT
RF4 IN
RF 3 OUT
RF 2
RF 1
DATA 1
DATA 2
AUX 3
SPEECH
13 dBm MAX
13 dBm MAX
2 W MAX
50 W MAX

Fig. 1-3 CMU front view – hardkeys

SYSTEM


SYSTEM
HELP
SETUP
PRINT

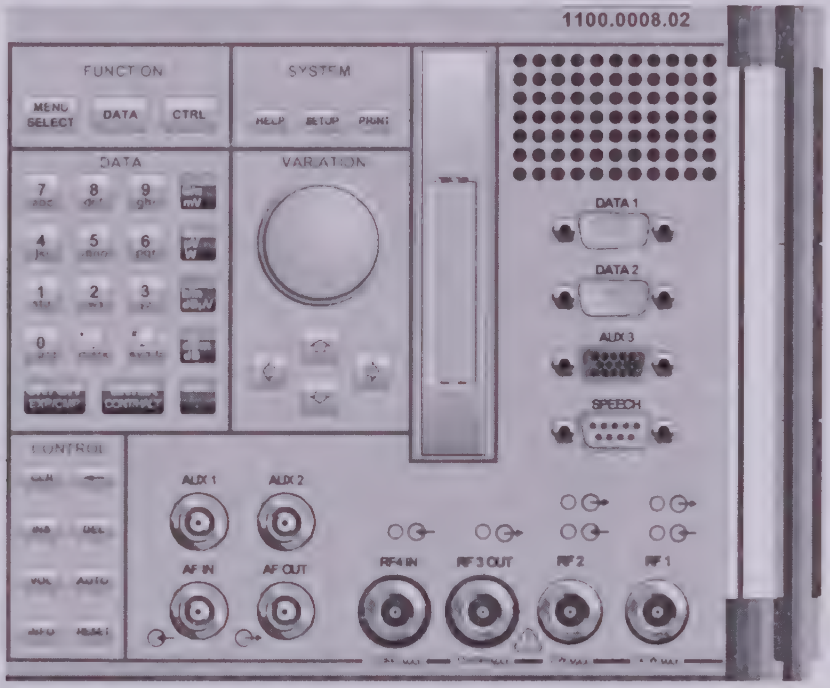
System control:

HELP	Displays online help	☞ Chap. 3
SETUP	Instrument settings	
PRINT	Initialize printing of a screenshot	

VARIATION

Value variation and group selection:

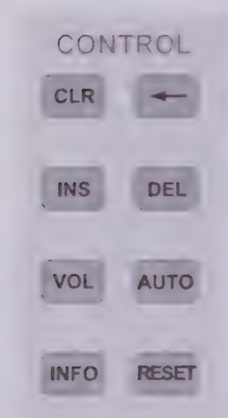
Rotary knob	Value variation in input fields and parameters, line selection in tables, field selection in popup menus. Press to expand/compress tables and pull-down lists and to confirm entries and selections.	☞ Chap. 3
Cursor key vertical	Group selection in popup menus (vertical)	
Cursor key horizontal	Group selection in popup menus (horizontal), Cursor positioning in editors and tables	


1100.0008.02
FUNCTION
MENU SELECT
DATA
CTRL
SYSTEM
HELP
SETUP
PRINT
DATA
7
8
9
4
5
6
1
2
3
0
VARIATION
DATA 1
DATA 2
AUX 3
SPEECH
CONTROL
AUX 1
AUX 2
AF IN
AF OUT
RF4 IN
RF 3 OUT
RF 2
RF 1

Extended editor and instrument control functions

Fig. 1-4 CMU front view – hardkeys

CONTROL

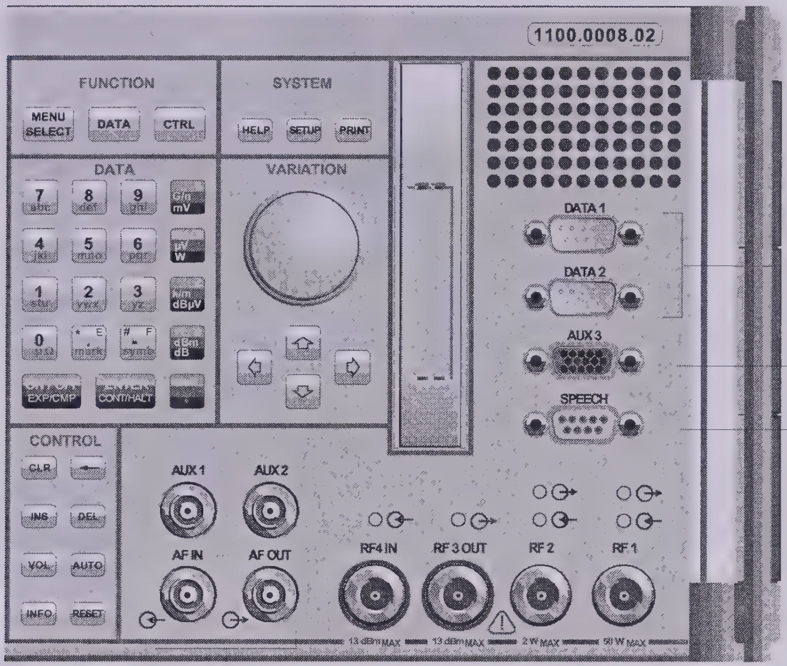

CONTROL
CLR
←
INS
DEL
VOL
AUTO
INFO
RESET

Extended control functions:

CLR	Clears the complete editor string	☞ Chap. 3
⇦	Deletes the character to the left of the cursor (back space)	
INS	Changes between insertion and overwriting in the editor	
DEL	Deletes the character marked by the cursor	
VOL	For future extensions	
AUTO	For future extensions	
INFO	System info and hardware diagnosis	
RESET	Resets to default values	

Further Keys

ESCAPE	Quits popup menus, closes an editor discarding the entries made	☞ Chap. 3
ON/STANDBY	Switches between operation (green LED) and standby (orange LED)	


1100.0008.02
FUNCTION
MENU SELECT
DATA
CTRL
SYSTEM
HELP
SETUP
PRINT
DATA
VARIATION
7 abc
8 def
9 ghi
G/n mV
4 jkl
5 mno
6 pqr
µV W
1 stu
2 vwx
3 yz
k/m dBµV
0
mark
symb
dBm dB
EXP/CMP
CONT/HALT
CONTROL
CLR
INS
DEL
VOL
AUTO
INFO
RESET
AUX 1
AUX 2
AF IN
AF OUT
RF4 IN
RF 3 OUT
RF 2
RF 1
DATA 1
DATA 2
AUX 3
SPEECH
13 dBm MAX
13 dBm MAX
2 W MAX
50 W MAX

For future extensions

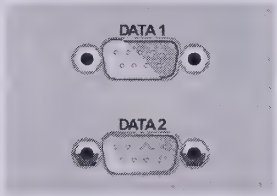
Auxiliary input/output AUX3

Signals from/to speech codec (option CMU-B52)

AF inputs and outputs

Fig. 1-5 CMU front view connectors

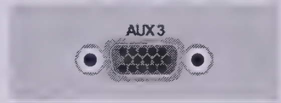
DATA1, DATA2


DATA 1
DATA 2

For future extensions

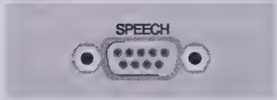
☞ Chapter 8, "Hardware connectors"

AUX 3 and SPEECH



Input/output for timing and external trigger signal
CMU300: External trigger signal for wired synchronization

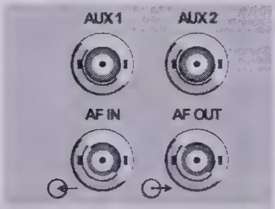
☞ Chapter 8, "Hardware connectors "



Signals from/to speech codec (option CMU-B52)

☞ Chapter 8, "Hardware connectors"

AF connectors

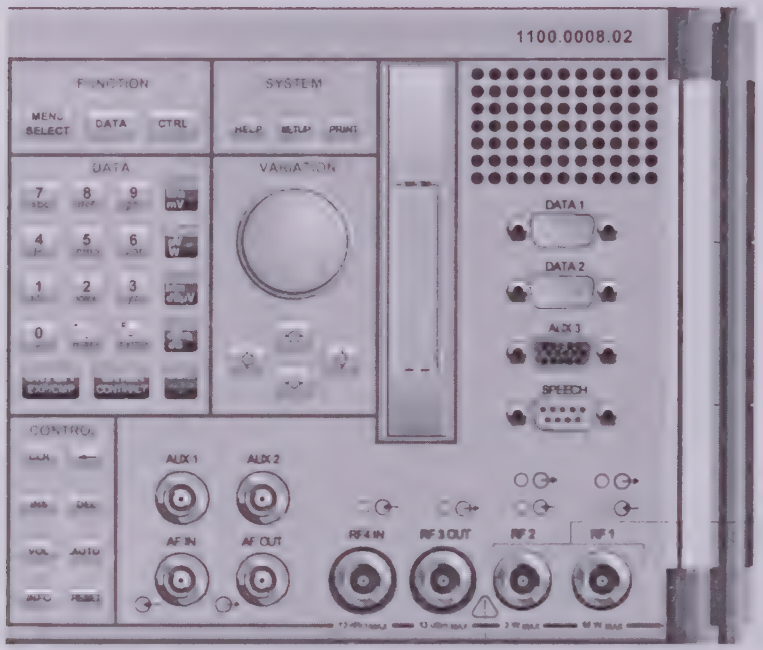

AUX 1
AUX 2
AF IN
AF OUT

Connectors for audio signals:

AUX1/2	Additional input/output for audio signals that may be used in remote control (secondary audio analyzer)
AF IN/OUT	Standard input/output for the (primary) audio analyzer

☞ Chapter 4, "Audio Generator and Analyzer"; Chapter 8, "Hardware connectors"

Caution: *Note the maximum permissible input levels for all AF connectors according to the data sheet in order to prevent damage to the instrument!*

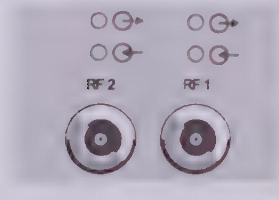

1100.0008.02
FUNCTION
MENU SELECT
DATA
CTRL
SYSTEM
HELP
SETUP
PRINT
DATA
VARIATION
DATA 1
DATA 2
AUX 3
SPEECH
CONTROL
AUX 1
AUX 2
AF IN
AF OUT
RF 4 IN
RF 3 OUT
RF 2
RF 1

Bidirectional RF connectors RF 1 und RF 2

Sensitive RF input, high-level RF output

Fig. 1-6 CMU front view– connectors

RF connectors



Bidirectional RF connectors for various power ranges according to the data sheet.

The two LEDs above the connectors are illuminated as long as the CMU sends signals ◯→ or is ready for reception ◯←.

☞ Chapter 8, "Hardware connectors "

RF4 IN
RF 3 OUT

Connector with high output level and connector for sensitive RF measurements (antennas). Power ranges according to the data sheet. Maximum permissible input and output level according to the label on the front panel.

☞ Chapter 8, "Hardware connectors"

The two LEDs above the connectors are illuminated as long as the CMU sends signals ◯→ or is ready for reception ◯←.

⚠

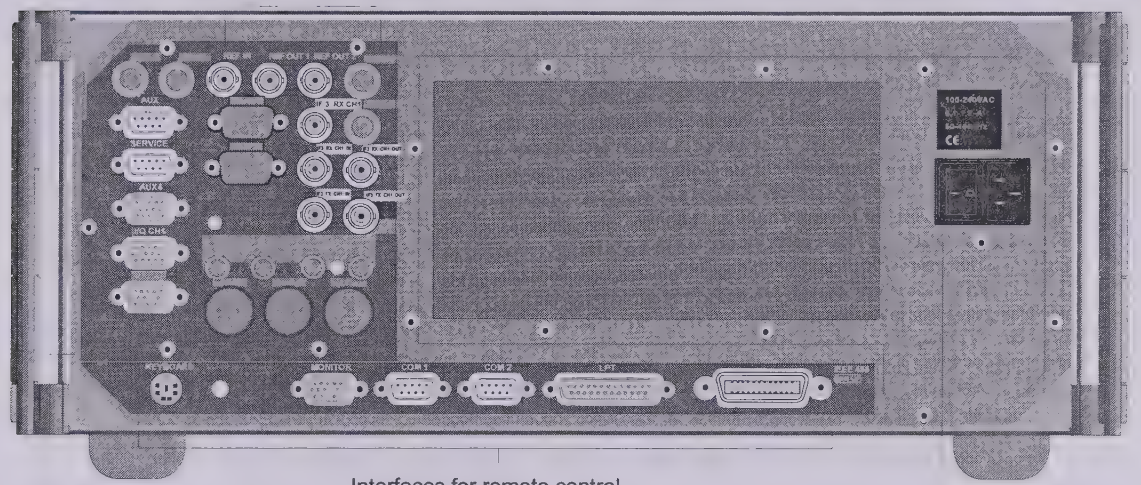
Caution:

Note the maximum permissible input levels for all RF connectors according to the label on the front panel or the data sheet in order to prevent damage to the instrument!

RF connectors may warm up very much when high RF power is fed in!

Rear View

Synchronization inputs and outputs, IF interface (with option CMU-B17)



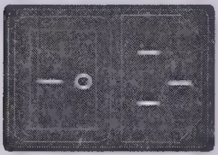
Signal inputs and outputs

Interfaces for remote control and peripheral equipment

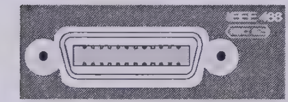
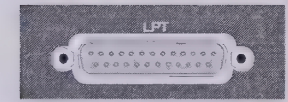
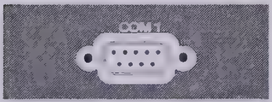
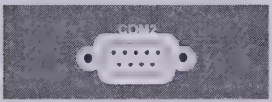
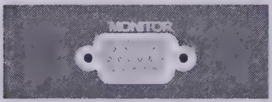
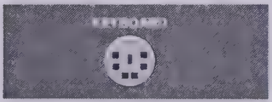
Mains connector with switch

Fig. 1-7 CMU rear view

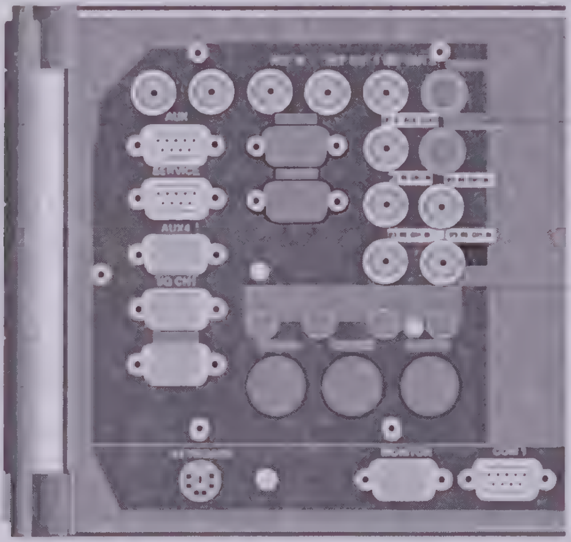
Mains switch

	Mains power switch	☞	Chapter 1, "Switching on the Instrument, Startup test"
	Mains connector	☞	Chapter 1, "Connecting the instrument to the AC supply"

Interfaces

	GPIB-bus connector (IEEE 488 / IEC 625),	☞	Chapter 8, "Hardware Interfaces "
	Parallel interface: 25-contact printer connector, Centronics-compatible	☞	Chapt. 1, "Connecting an Output Device" Chapter 8, "Hardware Interfaces"
	Connector for serial interface 1: 9-contact Sub-D connector	☞	Chapter 8, "Hardware Interfaces"
	Connector for serial interface 2: 9-contact Sub-D connector	☞	Chapter 8, "Hardware Interfaces"
	Connector for an external VGA monitor: 15-contact Sub-D connector	☞	Chapter 1, "Connecting a Monitor" Chapter 8, "Hardware Interfaces"
	Connector for external keyboard (PS/2), 6-contact Mini DIN connector	☞	Chapter 1, "Connecting an External Keyboard" Chapter. 8, "Hardware Interfaces"

Inputs and outputs for reference frequency and network-specific clock frequency



Auxiliary and service connectors, I/Q interface

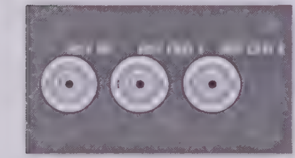
Intermediate frequency from CMU receiver, IF interface

Fig. 1-8 CMU rear view – signal inputs and outputs

Intermediate frequency

IF3 RX CH1 (BNC connector) from CMU receiver ☞ Chapter 8, "Hardware Connectors"

Reference frequency

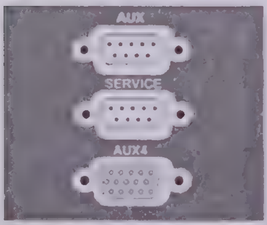


REF IN	Input for external reference frequency	☞	Chapter 8, "Hardware Connectors
REF OUT 1	Output of reference frequency of CMU 10 MHz or the signal of input REF IN		
REF OUT 2	Output for network-specific clock frequency	☞	Chapter 3, "RF Connection Control"

Caution!

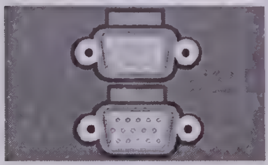
Do not use open or unshielded cables in order to comply with EMC directives!

AUX, SERVICE, AUX4, extensions



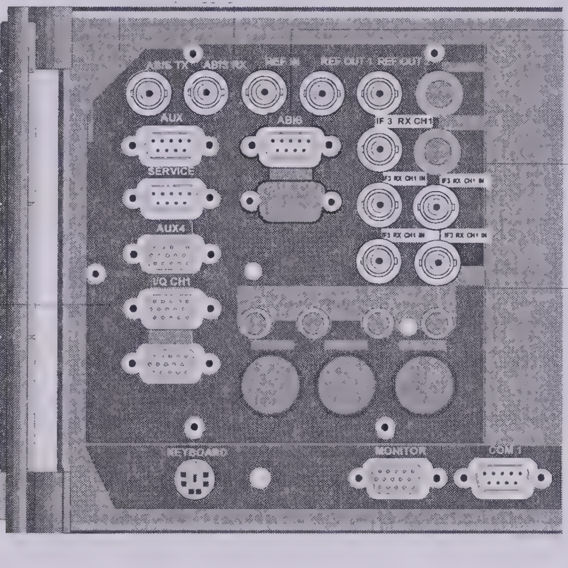
Two 9-contact and one 15-contact SUB-D connectors: ☞ Chapter 8, "Hardware Connectors

AUX	Auxiliary connector providing a DC voltage to supply external equipment such as CMU-Z6
SERVICE	Service connector for RXTX board (only for internal test purposes)
AUX4	Bidirectional input/output for digital status, control, and trigger signal



The remaining 15-contact SUB-D connectors are reserved for future extensions. ☞ Chapter 8, "Hardware Connectors

Input and output for Abis interface (CMU 300 only)


ABIS TX
ABIS RX
REF IN
REF OUT 1
REF OUT 2
AUX
ABIS
IF 3 RX CH1
SERVICE
AUX4
I/Q CH1
KEYBOARD
MONITOR
COM 1

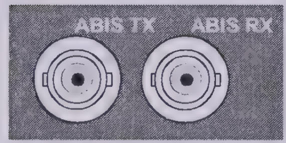
Balanced Abis interface (CMU 300 only)

IF interface (CMU 200 only)

I/Q interface (CMU 200 only)

Fig. 1-9 CMU rear view – Abis and I/Q-IF inputs and outputs

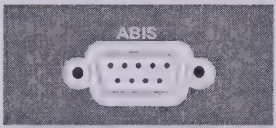
Abis connectors (CMU300 with option CMU-B71)


ABIS TX
ABIS RX

Two 75 Ω BNC connectors for option CMU-B71, *Abis Interface Unit for CMU* (for CMU300 only):

ABIS TX	For future extensions
ABIS RX	Input for PCM signals from a BTS under test to be applied to the CMU's Abis interface

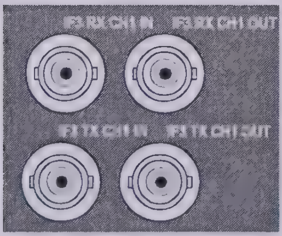
☞ Operating manual CMU-K30/-K31/-K32/-K33/-K34



9-contact SUB-D connector with alternative 120 Ω balanced input for Abis interface .

☞ Chapter 8, "Hardware Connectors"

I/Q-IF Interface (CMU200 with option CMU-B17)

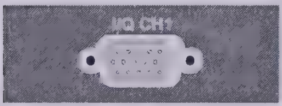

IF3 RX CH1 IN
IF3 RX CH1 OUT
IF3 TX CH1 IN
IF3 TX CH1 OUT

Four 50 Ω BNC connectors for option CMU-B17, *I/Q and IF Interface* (for CMU200 only):

IF3 RX CH1 IN	RX path, IF IN
IF3 RX CH1 OUT	RX path, IF OUT
IF3 TX CH1 IN	TX path, IF IN
IF3 TX CH1 OUT	TX path, IF OUT

☞ Chapter 4, "Hardware Connectors"

Chapter 8, "Hardware Connectors"



15-contact SUB-D connector for input and output of I/Q signals (option CMU-B17, *I/Q and IF Interface,* for CMU200 only)

☞ Chapter 8, "Hardware Connectors"

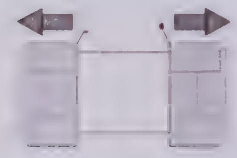
Note: *The CMU is delivered with different rear panel designs, however, the names of the connectors are unambiguous and used irrespective of the design.*

Putting the Instrument into Operation

Caution!

Please make sure to follow the instructions of the following sections in order not to cause damage to the instrument or endanger people. This is of particular importance when using the instrument for the first time.

Unpacking the Instrument



remove protective cabs

- ➢ Take the instrument out of the shipping box and check whether the items listed in the packing list (see separate yellow sheet after the title page of this manual) are all included.
- ➢ Remove the two protective caps from the front and rear of the CMU and carefully check the instrument for damage.

Should the instrument be damaged, immediately notify the forwarder who shipped the instrument to you and keep the box and packing material.

For further transport or shipment of the CMU the original packing should be used, too. It is recommended to keep at least the two protective caps for front and rear side in order to prevent damage to the controls and connectors. The caps are also necessary if the CMU is transported in its transit case that can be ordered from Rohde & Schwarz.

Setting up the Instrument

Permissible operating positions of the CMU

- Horizontal position, standing on the feet.
- For applications in the laboratory or on a work bench, it is recommended that the support feet on the bottom of the instrument be extended. For the LCD display, this provides the optimum viewing angle which typically ranges from perpendicular to the display front to approximately 30° below.

Warning!

The feet must be fully folded in or out. Only in this way can the stability of CMU be guaranteed and reliable operation be ensured. With the feet out, the weight of other units put onto CMU must not exceed 30 kg. The units must be secured against slipping (e.g. by locking the feet of the unit at the top side of the enclosure).

When moving the unit with the feet out, the feet might collapse and fold in. To avoid injuries, the unit must therefore not be moved with the feet out.

Notes: *For safe and convenient operation of the instrument note the following:*

- ➢ Do not cover the rear and lateral ventilation holes.
- ➢ Note the permissible ambient temperature according to the data sheet.
- ➢ Avoid moisture condensation. If it however occurs, the instrument must be wiped dry before switching on.
- ➢ Note the warm-up time of the temperature-controlled OCXO reference oscillator (Option CMU-B11/B12), see data sheet.

Mounting in a Rack

Using the adapter ZZA-411 (order number 1096.3283.00) the instrument can be mounted in 19" racks according to the mounting instructions supplied with the rack adapter.

Note: *For convenient operation of the instrument note the following:*

- Allow for sufficient air supply in the rack.
- Make sure that there is sufficient space between the ventilation holes and the rack casing.

Connecting the Instrument to the AC Supply

Caution!

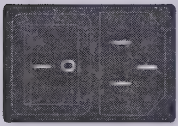
After moisture condensation, allow the instrument to dry before switching on.

Note the permissible ambient temperature according to the data sheet.

Do not cover the lateral and rear ventilation holes.

The CMU may be connected to one-phase AC supplies with nominal voltages ranging from 100 V to 240 V and nominal frequencies ranging from 50 Hz to 400 Hz (see inscription on the rear panel and data sheet). Depending on the options installed, the power consumption ranges from 120 W to 230 W.

Note: *The CMU is automatically adapted to the AC supply voltage applied. External switchover or adaptation of the fuses are not necessary.*



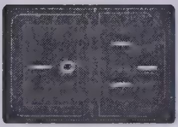
Mains connector

For the mains connection use the supplied mains connector.

As the instrument is designed according to the regulations for safety class EN61010, it must be connected to a power outlet with earthing contact.

Switching on the Instrument / Startup Test

The CMU can be switched on using the mains switch at the rear of the instrument and the *ON/STANDBY* key at the bottom left of the instrument front.

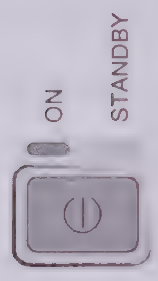


Mains switch

The *mains switch* can be set to two positions:

0 The *0* position implies an all-pole disconnection of the instrument from the mains.

I In the *I* position, the instrument is in standby mode or in operation, depending on the position of the ON/STANDBY key at the front of the instrument.



ON/ STANDBY key

The *ON/STANDBY* key activates two different operating modes indicated by colored LEDs:

Standby Only the OCXO reference frequency oscillator (Option CMU-B11/B12), if installed, is supplied with operating voltage. The orange LED (STANDBY) on the right is illuminated.

Operation In this operating mode, all modules of the instrument are supplied with operating voltage. The green LED (ON) on the left is illuminated.

Start procedure

- ➢ To switch on the CMU set the mains switch to the position I.

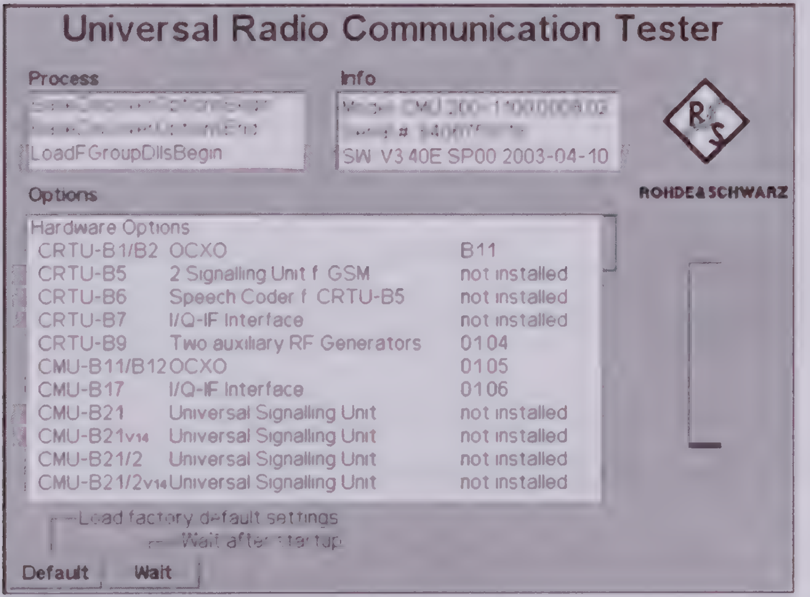
The CMU enters standby mode.

- ➢ Set the CMU to operating mode by pressing the *ON/STANDBY* key once.

Caution! *When switching on the CMU, no disk should be inserted in the drive; otherwise, one of the actions stored on the flash disk will be performed.*

Startup menu

After activation of the operating mode, the startup menu appears for a few seconds. While it is displayed the CMU performs a startup test.



Universal Radio Communication Tester

Process

LoadFGroupDllsBegin

Info

SW V3 40E SP00 2003-04-10

Options

Hardware Options

CRTU-B1/B2	OCXO	B11
CRTU-B5	2 Signalling Unit f GSM	not installed
CRTU-B6	Speech Coder f CRTU-B5	not installed
CRTU-B7	I/Q-IF Interface	not installed
CRTU-B9	Two auxiliary RF Generators	0104
CMU-B11/B12	OCXO	0105
CMU-B17	I/Q-IF Interface	0106
CMU-B21	Universal Signalling Unit	not installed
CMU-B21v14	Universal Signalling Unit	not installed
CMU-B21/2	Universal Signalling Unit	not installed
CMU-B21/2v14	Universal Signalling Unit	not installed

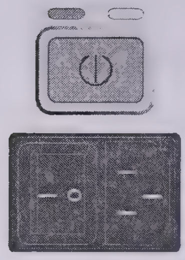
Displays in startup menu

The display windows of the startup menu provide information on

- The startup procedure (*Process*)
- Instrument model, serial number and version of the CMU base software *(Info)*.
- Installed hardware and software options and equipment *(Options)*. Available software options are listed with their version numbers.
- Progress of the startup procedure (*Startup* bar graph).

After terminating the startup procedure, the instrument changes to the last main menu or graphical measurement menu of the previous session.

Switching off the Instrument



In order not to lose any settings that have been made, proceed in the following order to switch off the CMU:

- Remove any storage medium from the PCMCIA interface or floppy disk drive.
- **Shortly** press *ON/STANDBY* to initiate the shutdown process and save the current data to the internal hard disk.
- Wait until the shutdown process has been terminated before setting the mains switch at the rear to the 0 position.

Note: *Instruments equipped with a Front Module controller FMR 6 display the message* Shutdown in Progress *after the ON/STANDBY key has been pressed. Keeping ON/STANDBY pressed for about 4 s on those instruments initiates a hardware shutdown where data may be lost.*

How to Ensure EMC

In order to avoid electromagnetic interference, the instrument may only be operated when it is closed and with all shielding covers fitted. Only appropriate shielded signal and control cables may be used.

Input Level

Caution!

– *In order to prevent damage to the instrument note the maximum permissible input levels at the AF inputs AF IN and AUX 1 as well as for the RF inputs RF 1, RF 2 and RF 4 IN at the front of the instrument.*

Connecting the CMU to the Test Setup

Warning:

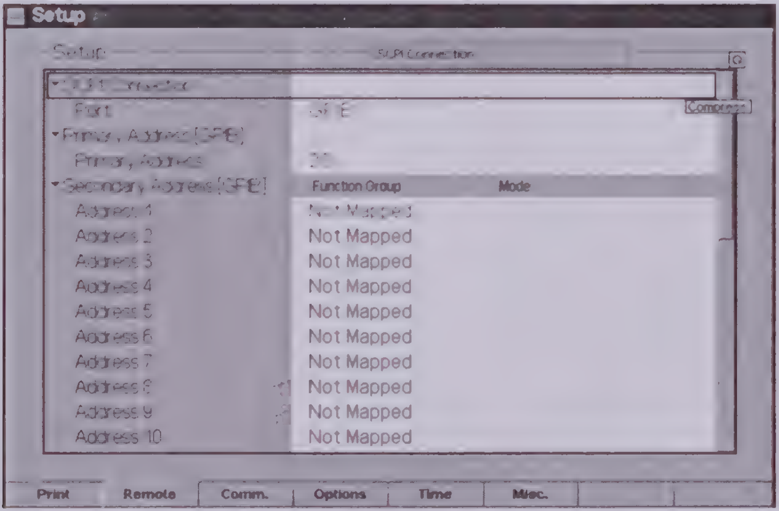
Connect external devices and peripherals only when the instrument is switched off or in STANDBY mode. Otherwise, future errors cannot be excluded.

Connecting a Controller

The CMU can be connected to an external controller via the GPIB bus (IEEE bus according to standard IEEE 488: throughout this documentation we will primarily use the term GPIB bus which is also used in the operating menus and in the SCPI command syntax) or via serial interface:

Connection via GPIB bus

The CMU is connected to the GPIB interface of the controller via the GPIB bus connector (IEEE 488 / IEC 625) at the rear of the instrument and a shielded cable. The technical specifications of the GPIB interface are listed in section "Hardware Interfaces " in Chapter 8.



SCPI Connection
Port: GPIB
Primary Address (GPIB)
Primary Address: 20
Secondary Address (GPIB)

	Function Group	Mode
Address 1	Not Mapped	
Address 2	Not Mapped	
Address 3	Not Mapped	
Address 4	Not Mapped	
Address 5	Not Mapped	
Address 6	Not Mapped	
Address 7	Not Mapped	
Address 8	Not Mapped	
Address 9	Not Mapped	
Address 10	Not Mapped	

GPIB Bus Configuration

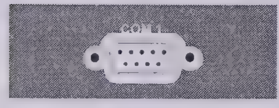
The parameters for GPIB bus control of the CMU are set in the *Remote* tab of the *Setup* popup menu (in the following abbreviated by *Setup – Remote*, see also chapter 4, *Settings for Remote Control*).

- ➢ To open the *Setup - Remote* menu, press the *SETUP* key at the front of the instrument and activate the *Remote* hotkey at the lower edge of the screen.
- ➢ Use the rotary knob to move the focus onto the *SCPI Connection* section of the *Setup* table. If necessary, press the rotary knob or the *ON/OFF* key to expand the parameters in the table (see Chapter 3).
- ➢ In the *Port* table row select the *GPIB* bus interface for transmission.

The bus address is factory-set to 20. It can be changed in the *Primary Address* input field.

Connection via serial interface

The CMU can be connected to the serial interface of a controller via one of the serial interfaces COM 1 or COM 2 and a so-called null-modem cable. The pin assignment and wiring of a null-modem cable are described in section *Handshake* of chapter 8. The technical specifications of the serial (RS-232-C) interface are also discussed in chapter 8 (refer to section *Hardware Interfaces*).



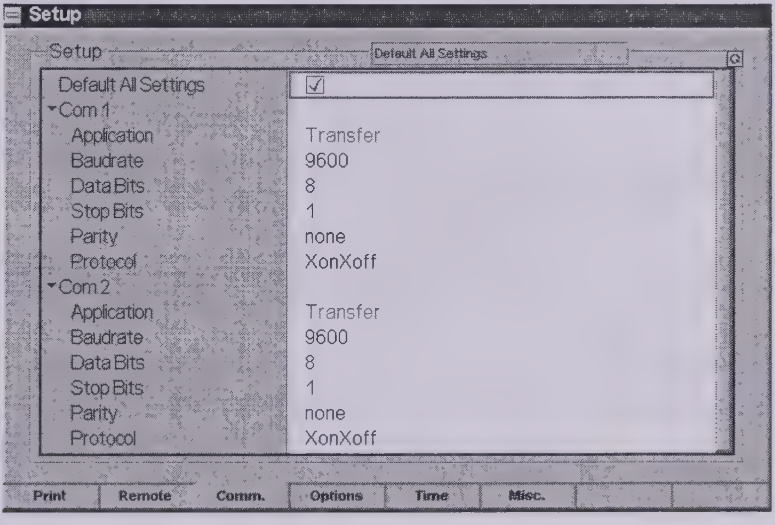
Either a 25-pin or a 9-pin connector can be used on the controller side. It may be necessary to use an appropriate adapter (see chapter 8, *Hardware Interfaces*).

Selection

- ➢ Proceed as described above to activate the *Remote* tab of the *Setup* menu.
- ➢ In the *Port* table row, select COM 1 or COM 2 to activate one of the RS-232 interfaces for data transfer.

Configuration

After selection of a serial interface, the transmission parameters must be set to comply with the parameters of the addressed device. This is done in *the Comm. (communications)* tab of the *Setup* menu:



Default All Settings	☑
Com 1	
Application	Transfer
Baudrate	9600
Data Bits	8
Stop Bits	1
Parity	none
Protocol	XonXoff
Com 2	
Application	Transfer
Baudrate	9600
Data Bits	8
Stop Bits	1
Parity	none
Protocol	XonXoff

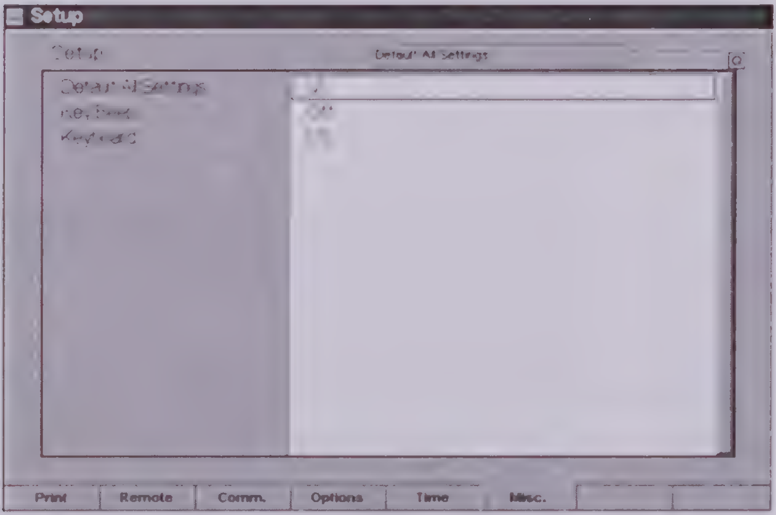
- ➢ To open the *Setup – Comm.* tab press the *SETUP* key at the front of the instrument and activate the *Comm.* hotkey at the lower edge of the screen.
- ➢ In the table section corresponding to the selected COM port check the settings for the *Baudrate, Data Bits, Parity,* and *Protocol.*

Connecting an External Keyboard

The 6-contact Mini DIN connector at the rear of the instrument permits to connect an external PC keyboard (PS/2) to the CMU. An external keyboard facilitates the input of numbers and texts.

For the interface description see section "Hardware Interfaces" in chapter 8.

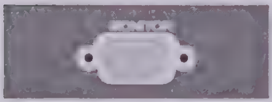
The assignment of the keys can be changed in the *Misc.* tab of the *Setup* menu:



Language assignment

- ➢ To open the *Setup – Misc.* tab press the *SETUP* key at the front of the instrument and activate the *Misc.* hotkey at the lower edge of the screen.
- ➢ Press the *Keyboard* softkey and set the desired key assignment *(US* or *German).*

Connecting a Monitor



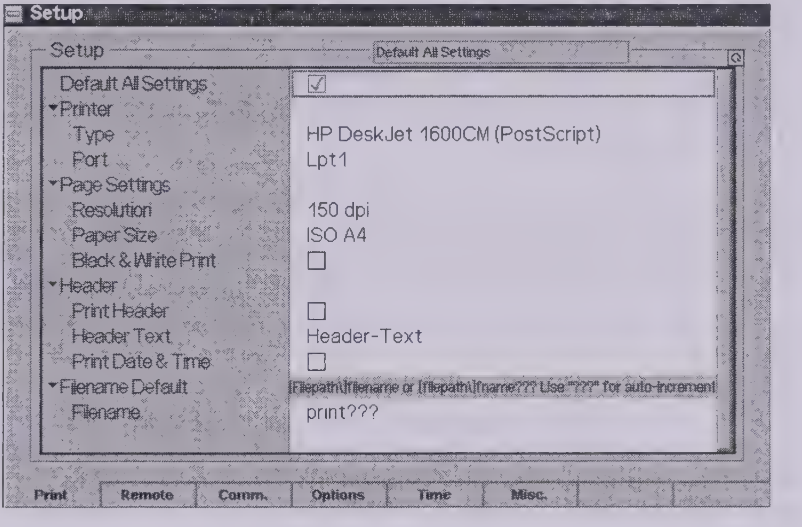
The 15-contact Sub-D connector at the rear of the instrument permits an external VGA monitor to be connected to the CMU.

For the interface description see section "Hardware Interfaces" in chapter 8.

Connecting a Printer

A printer can be connected via the 25-contact parallel interface *LPT* at the rear of the instrument (recommended) or one of the serial interfaces COM 1 or COM 2. For the interface description see section "Hardware Interfaces" in chapter 8.

The printer type and port must be set in the *Print* tab of the *Setup* menu:

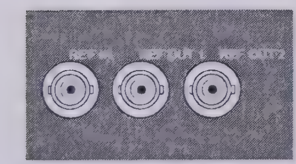


Default All Settings	☑
▾Printer	
Type	HP DeskJet 1600CM (PostScript)
Port	Lpt1
▾Page Settings	
Resolution	150 dpi
Paper Size	ISO A4
Black & White Print	☐
▾Header	
Print Header	☐
Header Text	Header-Text
Print Date & Time	☐
▾Filename Default	[Filepath\]filename or [filepath\]fname??? Use "???" for auto-increment
Filename	print???

- ➢ To open the *Setup – Print* tab press the *SETUP* key at the front of the instrument and activate the *Print* hotkey at the lower edge of the screen.
- ➢ In the *Printer* section set the printer type and port *(COM 1* or *COM 2* for the serial (RS-232) ports; *LPT 1* for the parallel printer port).

It is recommended to connect the output device to the parallel interface *LPT*, if possible: With this selection, configuration of the interface is not necessary; besides, the serial connectors may be used for GPIB bus etc.

Synchronization with External Devices; Connection of Further Components



The three BNC female connectors REF IN, REF OUT 1, REF OUT 2 are provided for synchronization of the CMU with external devices.

Software Update and Version Management

Your CMU was delivered with the latest software and firmware version available. New firmware can be easily installed via the floppy disk drive (option CMU-U61) or the PCMCIA interface on the front of the instrument. In this case, the additional software options must be enabled by means of a key code entered in the *Setup – Options* menu (see chapter 4).

Installation of new firmware versions and the use of different applications and versions on the same instrument is made easier by the *VersionManager* described in the following section. Installation instructions are also given in chapter 1 of the operating manuals for the individual software options.

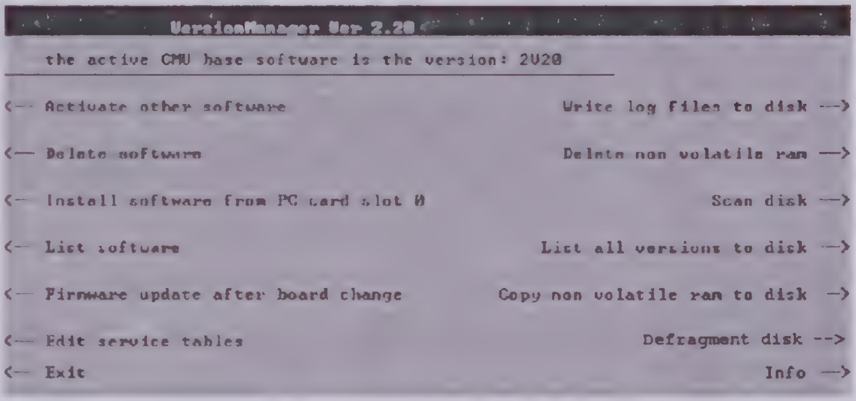
CMU VersionManager

The *VersionManager* is a tool designed to activate, delete, install, combine, or list different software versions in a convenient way. Moreover, it provides information on the hardware and software configuration of the instrument *(Edit service tables, Scan disk)*, resets the startup settings stored in the *non volatile ram*, copies information to an external storage medium *(Write log files to disk, List all versions to disk)*, and loads and activates user correction tables (see section *RF User Correction* on p. 1.27 ff.).

The *VersionManager* is part of each CMU firmware version. It is opened automatically after the boot-up process if the CMU detects a storage medium in its floppy disk drive/PCMCIA slot that contains an installation version of the CMU firmware. Alternatively, it can be called up by pressing the *Menu Select* key after the boot-up sequence is terminated (from the moment when the CMU display turns black until the end of the 3-beep acoustic signal).

with floppy / PCMCIA card or

MENU
SELECT

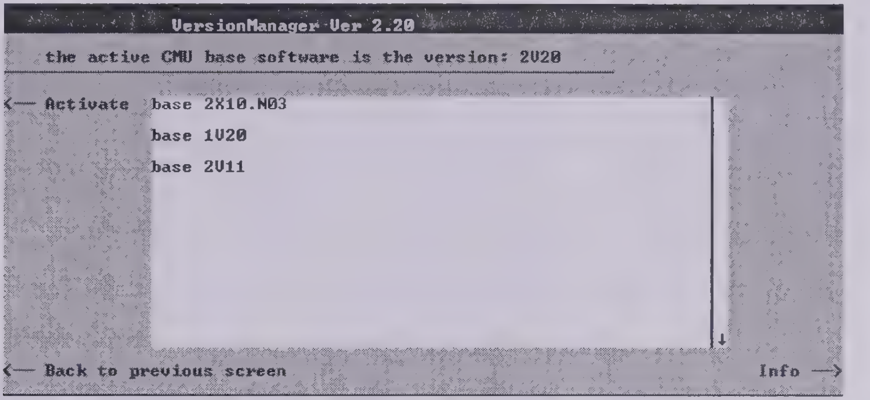


```
                    VersionManager Ver 2.20
    the active CMU base software is the version: 2V20

<-- Activate other software                    Write log files to disk -->

<-- Delete software                         Delete non volatile ram -->

<-- Install software from PC card slot 0                    Scan disk -->

<-- List software                         List all versions to disk -->

<-- Firmware update after board change  Copy non volatile ram to disk -->

<-- Edit service tables                              Defragment disk -->
<-- Exit                                                        Info -->
```

Fig. 1-9 VersionManager main screen (example)

The different functions of the *VersionManager* are activated by pressing the corresponding softkeys. Some of them (labeled optional below) are available in a particular configuration of the hard disk only. The upper two softkeys in both softkey bars are not assigned.

Activate other software (optional)	*Activate other software* opens a list of all firmware configurations stored on the CMU hard disk except the current configuration. Therefore, this function is not available if the hard disk contains only a single configuration (to retrieve information, *List software* can be used instead).



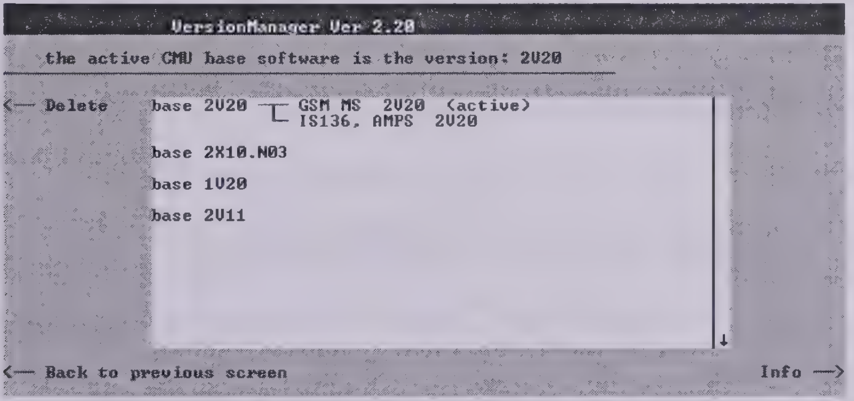
```
VersionManager Ver 2.20
the active CMU base software is the version: 2V20
<— Activate  base 2X10.N03
             base 1V20
             base 2V11
<— Back to previous screen                        Info —>
```

Each entry in the list corresponds to a firmware configuration consisting of exactly one CMU base software version (top level on the left side) plus a set of associated options[1] (network tests, second level). The version to be activated is displayed in red color on top of the list. To select another version, the list can be scrolled using the rotary knob or the cursor keys.

Activate	Activate the current firmware configuration.
Back to previous screen	Close the current screen and go back to the main screen. This option is identical in all *VersionManager* submenus.
Info	Open the *Info* screen associated to the current screen; see *Info on* p. 1.25. This option is identical in all *VersionManager* submenus.

Delete software (optional)

Delete software opens a list of all firmware configurations stored on the CMU hard disk. The dialog can be operated as explained above; see *Activate software*. The last firmware configuration can not be deleted, so this function is not available if the hard disk contains only a single configuration.



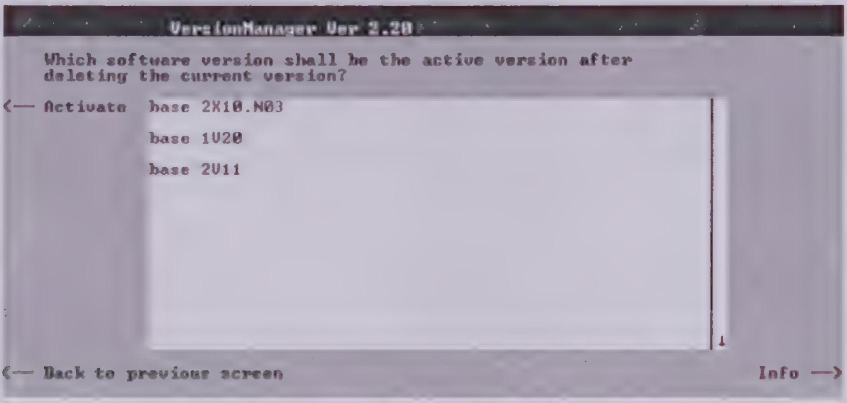
```
VersionManager Ver 2.20
the active CMU base software is the version: 2V20
<— Delete  base 2V20 ┬─ GSM MS   2V20  (active)
                     └─ IS136, AMPS  2V20
           base 2X10.N03
           base 1V20
           base 2V11
<— Back to previous screen                        Info —>
```

Delete	Delete the current firmware configuration.

If the active firmware configuration is deleted, the CMU asks which of the remaining versions shall be activated:

---

[1] Several related options may be displayed in a single line. These combinations of options can be installed together and will be simply referred to as "options" through the remainder of this section.



```
                 VersionManager Ver 2.20

   Which software version shall be the active version after
   deleting the current version?

<— Activate   base 2X10.N03

              base 1V20

              base 2V11

<— Back to previous screen                                Info —>
```

Activate Activate the current firmware configuration.

Install software... *Install software...* opens a list of all firmware installation versions available on an external storage medium (floppy disk/PCMCIA card). As explained in *Table 1-1*, this function depends on the type and number of storage media and on the number of installation versions available.

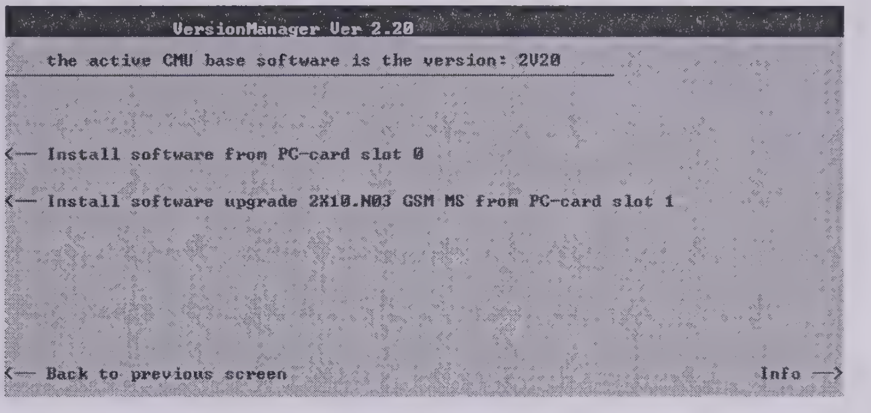
Table 1-1 Software installation with the *VersionManager*

Storage medium with FW installation version[2]	**Number of FW installation versions**	**VersionManager function**
Floppy	1	*Install software version <version> from floppy*
	several	*Install software from floppy* –> Open software version selection dialog (see below).
PCMCIA card in slot 0 or 1 (right or left side)	1	*Install software version <version> from PC-card slot <slot_no>*
	several	*Install software from PC-card slot <slot_no>* –> Open software version selection dialog (see below).
PCMCIA card in slot 0 and in slot 1	1 (per PC-card)	*Install software version <version> from PC-card* –> Open PC-card selection dialog (see below).
	several	*Install software from PC-card* –> Open PC-card selection dialog (see below).

PC-card selection dialog: The *PC-card* selection dialog selects either PCMCIA card slot 0 (right side) or slot 1 (left side) for installation.

---

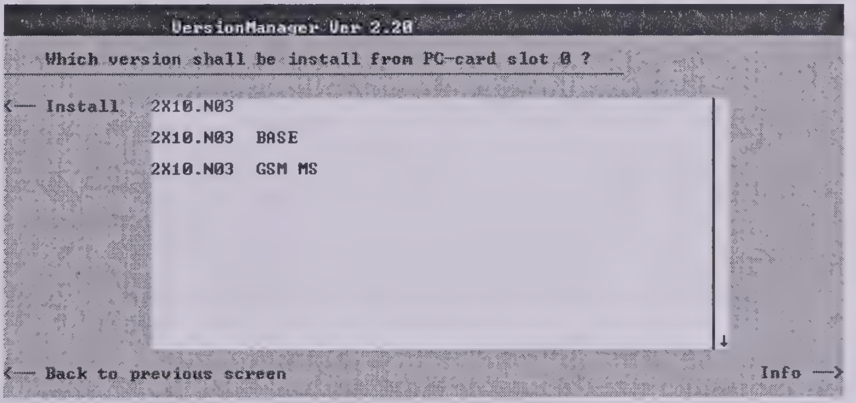
[2] Media without FW installation versions are ignored.



```
VersionManager Ver 2.20
the active CMU base software is the version: 2V20

<— Install software from PC-card slot 0

<— Install software upgrade 2X10.N03 GSM MS from PC-card slot 1

<— Back to previous screen                                    Info —>
```

Install software... Select the card in slot 0 or slot 1 as an installation medium. If the medium contains several installation versions, the *software version* selection dialog is called up, see below.

Software version selection dialog: The *software version* selection dialog lists all installation versions on the current medium (floppy, PCMCIA card). The dialog can be operated as explained above; see *Activate software*.

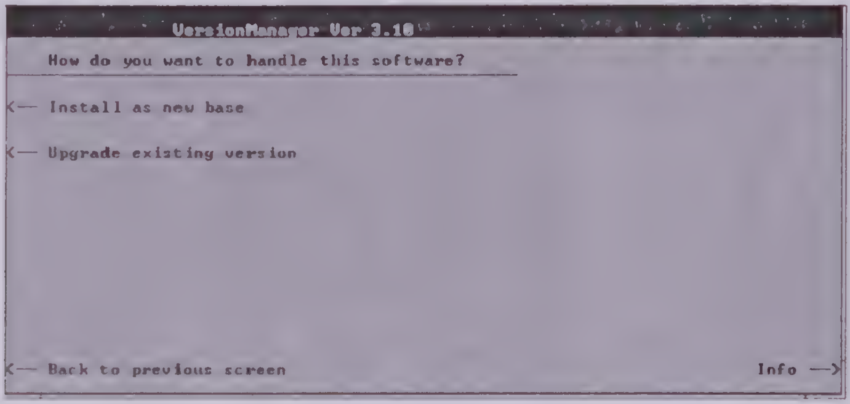


```
VersionManager Ver 2.20
Which version shall be install from PC-card slot 0 ?
<— Install   2X10.N03
             2X10.N03  BASE
             2X10.N03  GSM MS

<— Back to previous screen                                    Info —>
```

Install Install the current firmware version.

Upgrade options: In contrast to the *Activate software* dialog, the software selection dialog handles base software versions and network options separately. As a consequence, different versions of the base software can be combined with different options to create new firmware configurations. For example, it is possible to update the base software without affecting the associated network options or vice versa. Moreover, the same base software version can be installed several times and combined with different network options (and vice versa), so it may enter into several firmware configurations. The following simple rules apply:

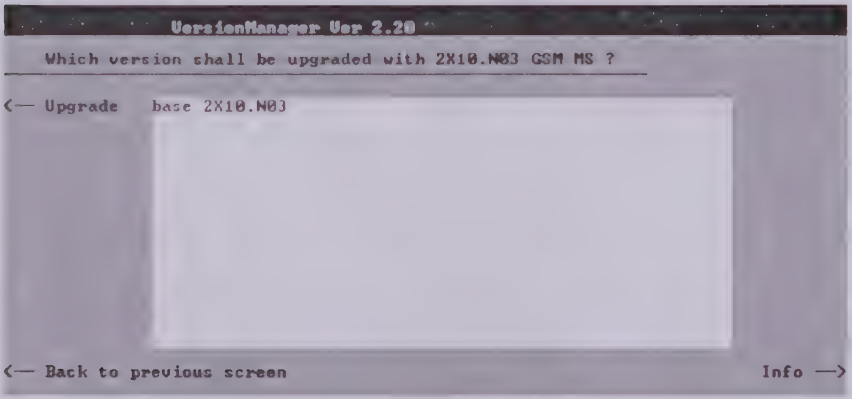
- With a new version of a network option, it is only possible to update one of the existing configurations. The following selection dialog is automatically skipped.
- With a new base software version, it is possible to either update an existing configuration or create a new one. A dialog selecting between the two alternatives is opened:


VersionManager Ver 3.10
<— Install as new base
<— Upgrade existing version
<— Back to previous screen
Info —>

How do you want to handle this software?

Note:	*This dialog is skipped if the new base software version is not compatible with any of the existing configurations. An incompatible new base software must be installed as a new base software.*
Install as new base	Create a new configuration based on the base software to be installed. The upgrade selection dialog described below is skipped. Network options can be assigned to this base software in a second stage of the installation.
Upgrade existing v.	Select an existing configuration and replace the base software of this version. To this end, the upgrade selection dialog described below is opened.
Force verm update	If the option is checked the current *VersionManager* is overwritten every time that a new base system is installed, even if this means a downgrade of the *VersionManager* version. This feature is primarily for service purposes.

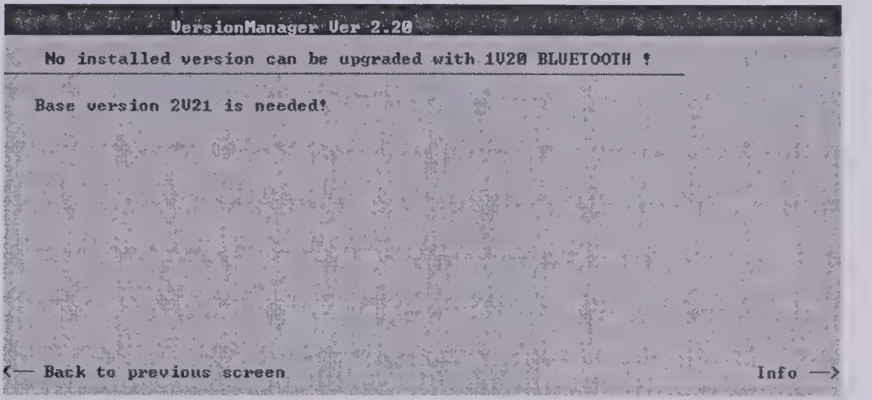
After selection of an upgrade software version compatible with one of the configurations stored on the hard disk, the upgrade selection dialog is called up:


VersionManager Ver 2.20
<— Upgrade
base 2X10.N03
<— Back to previous screen
Info —>

Which version shall be upgraded with 2X10.N03 GSM MS ?

Upgrade	Replace the base software version or network option selected in the *software version* selection dialog.

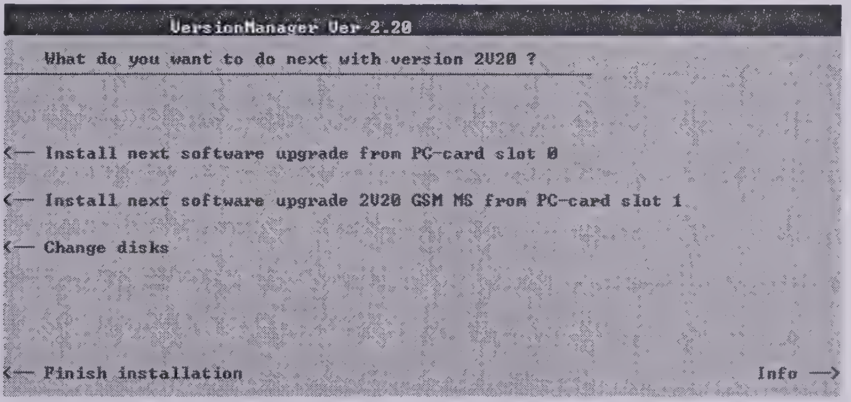
Alternatively, if none of the configurations stored on the hard disk is compatible with the software version selected, an error message is displayed. E.g., for an incompatible Bluetooth version:



```
VersionManager Ver 2.20
No installed version can be upgraded with 1V20 BLUETOOTH !

Base version 2V21 is needed!

<— Back to previous screen                                    Info —>
```

Back to...	Close the current screen and go back to the *software version* selection dialog to select a compatible software version.

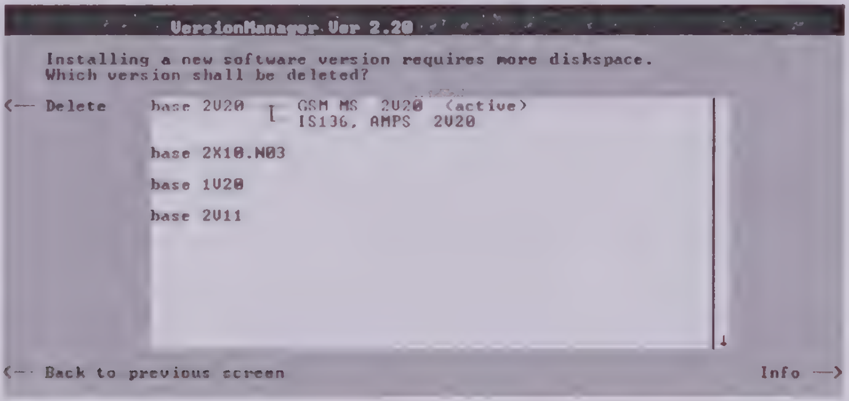
Terminating the software update: After successful installation of each software version the CMU displays the following screen:



```
VersionManager Ver 2.20
What do you want to do next with version 2V20 ?

<— Install next software upgrade from PC-card slot 0

<— Install next software upgrade 2V20 GSM MS from PC-card slot 1

<— Change disks

<— Finish installation                                        Info —>
```

Install next software...	Go back to the *software version* selection dialog to select additional software modules to be installed in the same *VersionManager* session. This function depends on the storage media and the number of software installation versions available; see *Table 1-1* on page 1.20.
Change disks	Update the current screen after a change of the storage medium.
Finish installation	Close the *VersionManager* and reboot the CMU (remove the external disk from the disk drive). The installed firmware configurations are then operational. The last configuration installed is taken as the active configuration in the subsequent measurement session.

Lack of disk space: Before installing the next software version, the CMU checks whether there is enough disk space on the hard disk. If not, the following dialog is displayed:



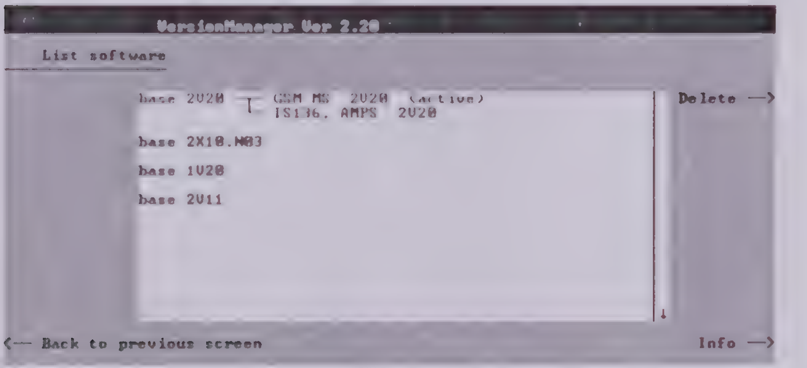
Installing a new software version requires more diskspace.
Which version shall be deleted?

VersionManager Ver 2.20
<— Delete
base 2V20
GSM MS 2V20 (active)
IS136, AMPS 2V20
base 2X10.N03
base 1V20
base 2V11
<— Back to previous screen
Info —>

Delete Delete the current version and return back to the previous screen.

List software

List software opens a list of all available firmware configurations. It is possible to activate and delete configurations from the list; see description of *Activate software* and *Delete software* functions above.


VersionManager Ver 2.20
List software
base 2V20
GSM MS 2V20 (active)
IS136, AMPS 2V20
base 2X10.N03
base 1V20
base 2V11
Delete —>
<— Back to previous screen
Info —>

Firmware update after board change(...)

This function depends on whether a user correction file named *USERCOR1.DAT* is stored in the directory *INTERNAL\USERCOR\* of the internal hard disk.

- If no user correction file is available, *Firmware update after board change* performs an update of the current firmware including a complete CMU hardware detection. No external installation disk is required. The update takes some time and should be attempted in case of problems or after a modification of the CMU hardware configuration only (also after a combined hardware/software exchange).
- If a user correction file is found, *Firmware update after board change…* opens a submenu to activate or deactivate the RF user correction; see section *Compiling and Loading User Correction Tables* on p. 1.28 ff.

Edit service tables

Edit service tables calls up the *Service Table Editor* menu showing all hardware modules that are possibly fitted in your instrument. For service purposes, further information can be obtained by typing a particular board name and board index in the two lines below the table.

Exit

Exit closes the *VersionManager* and resumes the CMU start-up procedure.

Write log files to disk

Write log files to disk copies all *.log files stored on the CMU hard disk to an external storage medium (floppy or PCMCIA card). The *.log source files on the hard disk are not deleted.

The *Write log files to disk* function opens a blue message box indicating the storage capacity of the external disk needed. The *.log files can be distributed over several disks. If no disk is available, the *VersionManager* displays a warning and does not start copying.

Delete non volatile ram

Delete non volatile ram deletes all entries stored in the non volatile ram of the CMU. This memory contains particular settings of the last CMU session that can be reused in the next session (e.g. the last active function group and measurement menu, special configuration etc.).

Deleting the non volatile ram can be useful after an abnormal termination of a CMU measurement session.

Note: *The settings stored in the non volatile ram can also be written to a configuration file and reused in later sessions; see Chapter 3, section* Saving Configurations.

Scan disk

Scan disk closes the *VersionManager,* executes the MS *Scan Disk* program and finally returns you to the *VersionManager*. Refer to your *Scan Disk* documentation for further information.

Note: *This function is not available while a base software version <V3.00 is active.*

List all versions to disk

List all versions to disk writes the software configurations indicated via *List software* to an ASCII text file that is stored on the external disk.

Copy non volatile ram to disk

Copy non volatile ram to disk copies the contents of the non volatile ram to the external disk (floppy, PCMCIA).
In this way, the settings stored in the non volatile ram can be used on another CMU.

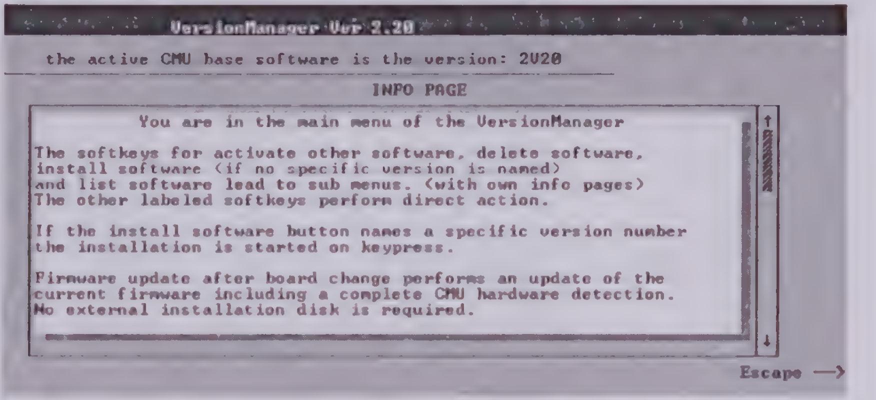
Defragment disk

Defragment disk closes the *VersionManager,* executes the MS *Defrag.exe* program and finally returns you to the *VersionManager*. Defragmenting the hard disk is suitable to improve performance after installing and deleting many different software versions. Refer to your *Defrag.exe* documentation for further information.

Note: *This function is not available while a base software version <V3.00 is active.*

Info

Info opens an output window displaying information on the current screen. Separate *Info* windows are provided for the different *VersionManager* dialogs.



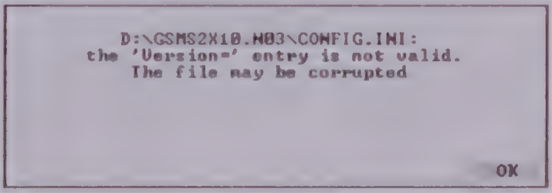
```
the active CMU base software is the version: 2V20

INFO PAGE

You are in the main menu of the VersionManager

The softkeys for activate other software, delete software,
install software (if no specific version is named)
and list software lead to sub menus. (with own info pages)
The other labeled softkeys perform direct action.

If the install software button names a specific version number
the installation is started on keypress.

Firmware update after board change performs an update of the
current firmware including a complete CMU hardware detection.
No external installation disk is required.
```

Escape Close the Info screen and return to the previous screen.

Error and notify message

During operation, the *VersionManager* can display two different types of messages:

- Error messages indicating that an action could not be successfully performed are displayed in yellow boxes. All error messages with possible reasons and remedial actions are explained in Chapter 9 of this manual.



```
D:\GSMS2X10.N03\CONFIG.INI:
the 'Version=' entry is not valid.
The file may be corrupted
```

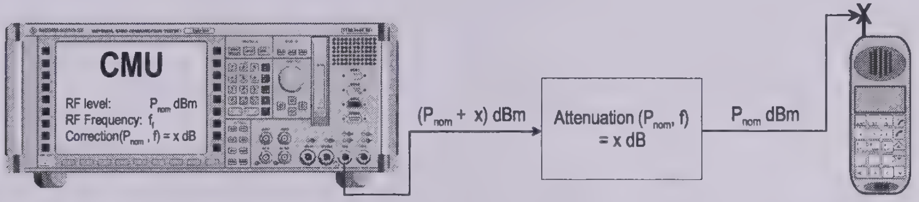
- Notify messages describing ongoing processes of the instrument are displayed in blue boxes. These messages are self-explanatory and do not require an action to be taken by the user.

RF User Correction

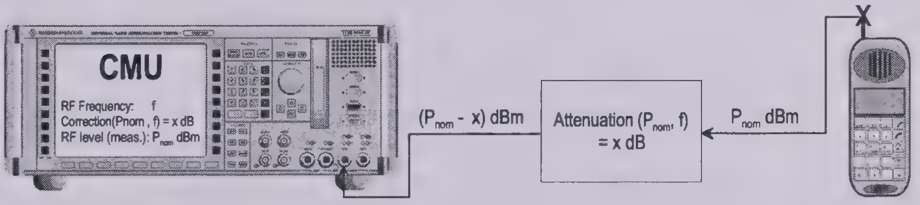
The purpose of the RF user correction is to compensate for an inevitable frequency and level-dependent attenuation in the test setup (frequency and level response correction). Level correction values are determined by means of a signal generator or power meter connected to the CMU's input and output ports and stored to a file, which is transferred to the CMU in order to modify its RF generator level and to correct its RF analyzer results.

The correction values must be acquired independently for the input and output connectors of the instrument.

Output level correction The correction values for output signals (connectors RF1, RF2 or RF3 OUT) modify the RF generator level so that the actual RF signal power at the input of the DUT is equal to the nominal RF generator level.



Input level correction The correction values for input signals (connectors RF1, RF2 or RF4 IN) modify the measured analyzer level so that the result for the RF signal power is equal to the power transmitted by the DUT.


CMU
RF Frequency: f
Correction(Pnom , f) = x dB
RF level (meas.): P_{nom} dBm
(P_{nom} - x) dBm
Attenuation (P_{nom}, f) = x dB
P_{nom} dBm

Once the correction tables have been transferred to the instrument, the RF user correction is an internal procedure. There are several advantages of using this internal correction method rather than post-processing the CMU results by means of an external measurement program:

- The input level correction affects all acquired RF power results[3] including derived quantities (e.g. the results of the limit check) without slowing down the speed of the measurements. Evaluating derived quantities by means of an external program can be tedious. The RF user correction ensures that all results, including the derived ones, are consistent.
- The user correction is included in all results displayed in the measurement menus.
- Correction data can be acquired individually for each instrument and stored to its internal hard disk. If several testers are used in a production measurement system, the individual units are independent from each other and interchangeable.

---

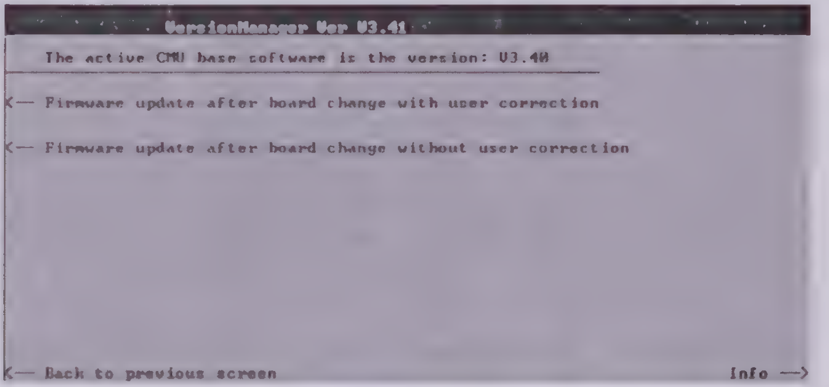
[3] Exception: The wideband power, which is provided in the *Analyzer/Generator* menu of the *RF* function group and in many network test applications, is always uncorrected.

Compiling and Loading User Correction Tables

To generate user correction tables and activate the user correction proceed as follows:

To deactivate old user correction (if available)...

1. Start the CMU and press the *Menu Select* key after the boot-up sequence is terminated (from the moment when the CMU display turns black until the end of the 3-beep acoustic signal) to activate the *VersionManager*.
2. Select *Firmware update after board change…*
3. In the submenu opened, select *Firmware update after board change without user correction* and *Back to previous screen.*



```
VersionManager Ver V3.41
  The active CMU base software is the version: V3.40
<— Firmware update after board change with user correction
<— Firmware update after board change without user correction
<— Back to previous screen                                   Info —>
```

The CMU closes the *VersionManager* and resumes the start-up procedure.

4. Open the *Data* menu and access the *Arrange* tab. Delete or rename the old user correction file stored in the directory *INTERNAL\USERCOR\USERCOR1.DAT*.
5. Press *Menu Select* to close the *Data* menu and access the *Menu Select* menu.

Settings for acquiring correction values

The following settings and precautions will ensure maximum accuracy of the user correction:

6. From the *Menu Select* menu, access the *RF* function group or one of the network test options that will be used for the corrected measurements.
7. In the *RF* tab of the *Connection Control* menu, select the external input and output attenuation factors *(Ext. Att. Input, Ext. Att. Output)* that will be used for the corrected measurements.
8. In the *Analyzer* tab of the *Connection Control* menu, select the RF input path attenuation *(Analyzer Level – RF Attenuation: Normal, Low Noise* or *Low distortion)* that will be used for the corrected measurements and set the *RF Mode* to *Manual*.

   Note: *The CMU provides a various mechanisms for automatic input level control, e.g. the* Analyzer Level – RF Modes *Auto (autoranging) and PCL (in GSM-MS networks). To avoid unexpected effects, it is recommended to deactivate these control mechanisms and always measure the correction values at constant* (Manual) *maximum input level.*

To acquire the input correction values...

9. Apply the RF output signal of an external signal generator to one of the RF input connectors RF1, RF2, or RF4 IN of the CMU using the test setup (cables, power splitters, antenna coupler...) that will be used for the corrected measurements.
10. Vary the level and frequency of the signal generator and calculate the correction values as the difference between the external generator level and the measurement result at the CMU. If necessary, adapt the external input attenuation (see step 7) to force the correction values into the allowed range of [–1.2 dB, +1.2 dB].

To acquire the output correction values...

11. Apply the RF generator signal of the CMU to one of the RF output connectors RF1, RF2, or RF3 OUT of the CMU and feed it to a power meter, using the test setup (cables, power splitters, antenna coupler...) that will be used for the corrected measurements.
12. Vary the level and frequency of the CMU generator signal and calculate the correction values as the difference between the generator level and the measurement result at the external power meter. If necessary, adapt the external output attenuation (see step 7) to force the correction values into the allowed range of [–1.2 dB, +1.2 dB].

To activate the user correction...

13. Repeat the steps no. 9 and 11 for all input and output connectors needed and write the acquired correction values into a common file named *USERCOR1.DAT* with the format specified in section *File Format for User Correction Tables* on p. 1.30 ff.
14. Transfer the file to the CMU using the IEEE bus, the serial interface or the PCMCIA interface and copy it to the directory *INTERNAL\USERCOR\*.
15. Shutdown and re-start the CMU and press the *Menu Select* key after the boot-up sequence is terminated (from the moment when the CMU display turns black until the end of the 3-beep acoustic signal) to activate the *VersionManager* again.
16. Select *Firmware update after board change...*
17. In the submenu opened (see step no. 3), select *Firmware update after board change with user correction.*

The CMU checks the file *USERCOR1.DAT* for compatibility with the file format specification and generates a message, should an error be detected. Afterwards, the CMU closes the *VersionManager* and resumes the start-up procedure. A message indicates that the user correction is active.

Final test

18. Repeat the steps no. 9 and 11 with active user correction to make sure that the entire procedure was performed without errors.

File Format for User Correction Tables

The user correction file is an ASCII file named *USERCOR1.DAT* that is stored in the directory C:\INTERNAL\USERCOR\ on the internal hard disk of the CMU. The file contains up to 6 independent tables to store the correction values for the 3 RF output connectors and the 3 RF input connectors of the instrument. Each table has the following structure:

[PortID]:	[Freq*1*]	[Freq*2*]	...	[Freq*n*]
[Level*1*]:	[Dev*11*]	[Dev*12*]	...	[Dev*1n*]
[Level*2*]:	[Dev*21*]	[Dev*22*]		[Dev*2n*]
⋮	⋮	⋮	⋮	⋮
[Level*m*]:	[Dev*m1*]	[Dev*m2*]	...	[Dev*mn*]

Comments in the file must be introduced by a double dagger #. Spaces and indentations are allowed for easier readability of the file. The first character in a line can be a minus sign but must not be a plus sign. The following example shows a valid user correction file:

```
# This is a comment
#   (any number of spaces is allowed)
    # indentations are allowed,

# spaces and TAB are used for separation

RF2in:    500    1000    1500    2000
 10:     1.20   -1.2    -.23     -0.5   # comments are allowed at the end of a line
  0:     0.34    1.14   1.20     -1.2
-10:     1.19   -1.19   -1.12    1.00
-14:     -0.32  +1.11  -0.50     1.10

 RF1in:    200     800     1500
 10:        +1.20   -.91    .5
 0:         -0.12   +1.11   -0.50

RF3OUT:   400    1000    1555    2500
 10:     1.20   -1.20   -0.23    -0.5
  0:     0.34    1.14    1.20    -1.2
-10:     1.19   -1.19   -1.12     1.00
-14:   -0.12   +1.11   -0.50      1.10
```

Note: *In general RF user correction tables are no longer valid after an update of the path correction data, e.g. by means of the automatic calibration system R&S ACS. To ensure that outdated user correction data are not used inadvertently, the ACS renames all files c:\internal\usercor\ *.dat ➡ c:\internal\usercor\ *.bak after a change of the path correction data. Existing *.bak files are overwritten.*

Ranges of Values and Limitations

The table contains the following elements:

PortID Identifier for the RF connector, written in upper or lower case letters and followed by a colon. The following port IDs are valid:

RF1IN, RF2IN, RF4IN	for the 3 RF input connectors (input level correction)
RF1OUT, RF2OUT, RF3OUT	for the 3 RF output connectors (output level correction)

Frequency points Frequency of the measured or generated signal in MHz, to be arranged in ascending order, starting in column 2 (lowest frequency). The frequency points must be integer numbers (i.e. integer multiples of 1 MHz) and can be distributed across the entire RF input and output frequency range of the instrument (see data sheet).

Level points	Level of the measured or generated signal in dBm, to be arranged in descending order, starting in row 2 (highest level). The level points must be positive or negative integer numbers, followed by a colon, and can be distributed across the entire RF input and output power range of the connectors (see data sheet). Negative levels must be preceded by a minus sign "-"; using a plus sign "+" for positive numbers is not allowed.
Correction values	n times m level correction values for the measured or generated signal in dB (if n is the number of frequency points, which is equal to the number of correction values per table row, and m is the number of level points). The total number of correction values n times m must not exceed 120 (it is possible though to choose m=120 and n=1 and vice versa).

The level correction values must be in the range between -1.20 dB and +1.20 dB. This is sufficient to compensate for a frequency response or level response caused by the test setup. Larger, correction factors can be defined by combining the user correction with a constant external input or output attenuation (see section *RF Connectors* in Chapter 4). Two consecutive correction values may be separated by any number of spaces or tabs.

Positive (negative) correction values for an output signal compensate for an external attenuation (gain) and increase (decrease) the generator level. Positive (negative) correction values for an input signal are added to (subtracted from) the measured RF signal levels.

Interpolation Rules

The CMU uses the values in the correction tables to interpolate correction factors at arbitrary frequency and level values. The following rules apply:

- At constant frequency, the correction value associated to the level point P_m is valid in the level range between $(P_{m+1} + P_m)/2$ and $(P_{m-1} + P_m)/2$: The ranges with constant value adjoin each other in the middle between two consecutive level points.
- At constant level, the correction factors are linearly interpolated between consecutive frequency points.

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2 Getting Started

The following Chapter presents a sample session with the universal radio communication tester CMU. It is intended to provide a quick overview of the settings provided in the base system and the *RF* function group. No specific device under test is required. For an introduction to mobile network tests (e.g. tests of GSM900/1800/1900 mobile phones) please refer to the relevant operating manuals.

Before starting any measurement with the CMU, please note the instructions given in Chapter 1 for putting the instrument into operation. In Chapters 2 to 4 you will find detailed information on customizing the instrument and the display according to your personal preferences.

The steps to perform are explained on the left side of each double-page together with the results obtained on the CMU screen. On the right side, additional information is given. We also point out alternative settings and related measurements which could not be reported in detail.

For a systematic explanation of all menus, functions and parameters and background information refer to the reference part in Chapter 4.

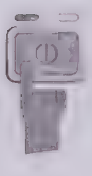
A Short Tutorial on CMU Operation

The principles of manual operation – controls, operating menus, dialog elements and measurement control – are discussed in Chapter 3. Below we list some essentials for first users:

Condensed Operating Instructions

1. When using CMU for the first time it is useful to set it to the default state (*RESET* hardkey).
2. *ENTER* key: press even if "No" or "Yes" is displayed.
3. There is no Home menu but the *MENU SELECT* hardkey can be pressed in any state of the unit. A large popup menu is then displayed in which the function group (network etc.), signalling mode and measurement menus can be selected. Activate by pressing *ENTER*.
4. A front-panel LED indicates which of the RF connectors is configured as output. In the menu, the RF generator can be activated or deactivated with *ON/OFF* (green/red). The front-panel LED goes out if the generator is in the *OFF* position.
5. A front-panel LED indicates which of the RF connectors is configured as input. In the menu, the measurement can be controlled via the *ON/OFF* and *CONT/HALT* keys (*ON* (green), *OFF* (red) and *HLT* (yellow) states). In the *OFF* state, the LED goes out.
6. The *SETUP* hardkey allows to make static, measurement-independent default settings such as *Remote* or *Time*, to check which options are installed and to activate new software options.
7. The left softkey row is missing in the graphical menus. The softkeys on the right-hand side are used to change the hotkeys across the bottom and their functions. Pressing the *Menus* softkey (bottom right) allows a fast switchover between related menus using the hotkeys.
8. Signalling does not necessarily have to be activated by means of a general menu; for example, the *Power* menu for GSM mobile tests can be called up immediately, without transferring any signalling information. The user is popup-menu guided (as default) through the different CMU signalling states (messages: switch mobile on, registered, call setup). This menu guidance via popup menu can be switched off.

How to access and close menus



A startup menu is displayed automatically when the CMU is switched on.

Some general configuration and selection menus can be opened via the *MENU SELECT, RESET, INFO, PRINT, HELP* or *SETUP* keys on the front panel.

The hotkeys displayed across the bottom of a main menu or graphical measurement menu are used to switch over between different main menus or graphical measurement menus. Tabs in popup menus are also accessible via hotkeys.

Group Config.

In firmware versions <V3.05, the *Group Config.* softkey (always at the top left) is available in all measurement menus. This softkey opens a popup menu defining the input path and the trigger settings for the current function group and signalling state.

The *Group Config.* softkey is omitted in firmware V3.05 and later. Instead, the settings are available in the *Connection Control* menu, see below.

Connect. Control

The *Connect. Control* softkey (always at the top right) is available in all measurement menus. This softkey opens a popup menu defining the input and output connectors, the external attenuation, the reference frequency as well as many network-specific settings.

In the *Signalling* test modes of many network options, the *Connection Control* menu is also used to set up and terminate a connection between the CMU and the DUT.

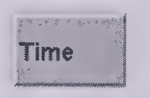
In firmware versions V3.05 and later, the *Connection Control* menu also contains the input path and the trigger settings for the current function group and signalling state.

If a special configuration menu exists for a measurement or for a generator the corresponding softkey is marked with a yellow arrow. The configuration menu is opened by pressing the softkey twice.

All CMU popup menus can be closed with the *ESCAPE* key.

Main menus and graphical measurement menus are closed on switching to another main or graphical measurement menu.

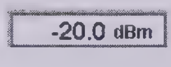
How to use dialog elements in the menus



The dialog elements assigned to a softkey are selected by pressing the softkey.

Different input fields can be selected by means of the 4 cursor keys (blue frame shows active input field).

One of several elements in a list or toggle switch can be selected with the rotary knob.



Numeric values can be either incremented/decremented using the rotary knob or entered via the numeric keypad or an external keyboard.

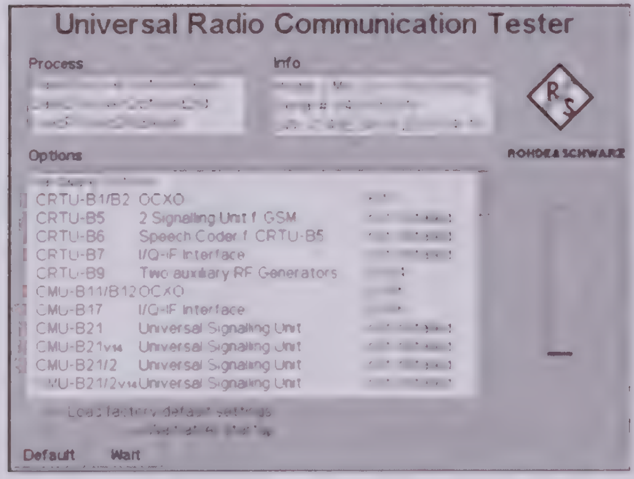
For a comprehensive introduction to manual operation of the CMU refer to Chapter 3.

Startup of the CMU

This Chapter describes how to customize the CMU and perform simple RF measurements. As a prerequisite for starting the session, the instrument must be correctly set up and connected to the AC power supply as described in Chapter 1.

Step 1

- ➢ Switch on the CMU using the mains switch at the rear. ①
- ➢ Check the operating mode of the instrument at the *ON/STANDBY* key on the front panel. If the CMU is in standby mode, press the *ON/STANDBY* key. ②


Universal Radio Communication Tester
Process
Info
ROHDE&SCHWARZ
Options
CRTU-B1/B2 OCXO
CRTU-B5 2 Signalling Unit f. GSM
CRTU-B6 Speech Coder f. CRTU-B5
CRTU-B7 I/Q-IF Interface
CRTU-B9 Two auxiliary RF Generators
CMU-B11/B12 OCXO
CMU-B17 I/Q-IF Interface
CMU-B21 Universal Signaling Unit
CMU-B21v14 Universal Signaling Unit
CMU-B21/2 Universal Signaling Unit
CMU-B21/2v14 Universal Signaling Unit
Load factory default settings
Default
Wait

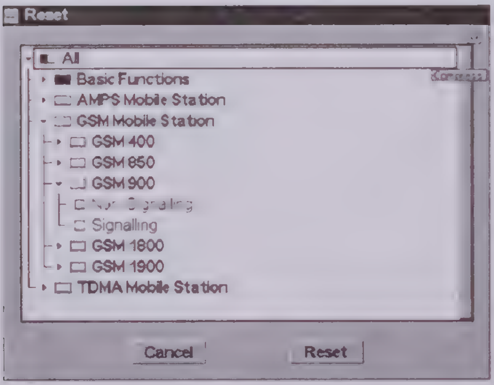
Step 2

The CMU is booted and after a short while displays the startup menu. This menu is usually closed as soon as the instrument software is loaded and the startup test is finished. ③

- ➢ Press the *Wait* hotkey to prevent the instrument from switching to another menu. ④

The *Wait* hotkey changes to *Cont.* with the additional message *Change to last menu* displayed on top.

- ➢ Press the *Cont.* hotkey to resume the startup process.


Reset
All
Basic Functions
AMPS Mobile Station
GSM Mobile Station
GSM 400
GSM 850
GSM 900
Non Signalling
Signalling
GSM 1800
GSM 1900
TDMA Mobile Station
Cancel
Reset

Step 3

- ➢ Press the *RESET* key to open the *Reset* popup menu.
- ➢ Proceed as described in Chapter 4, section *Reset of Instrument Settings*, to expand the tree of function groups.
- ➢ Select the function groups *Base* and *RF* to be reset (the corresponding nodes must be black).
- ➢ Use the cursor keys to activate the *Reset* button and press *ENTER*.
- ➢ In the popup window opened *(Are you sure?)*, select *Yes* to confirm the instrument reset.

The CMU indicates that it performs a partial reset of the two selected function groups and is then ready to carry out the following steps. The *Reset* popup menu is closed automatically.

Additional Information...

Alternative Settings and Measurements

... on Step 1

① **Mains switch on the rear panel**

When the mains switch at the rear is set to the *O* position, the complete instrument is disconnected from the power supply. When the mains power switch is set to the *I* position, the instrument is in standby mode or in operation, depending on the position of the *ON/STANDBY* key on the front panel.

☞ Chapter 1

The CMU is automatically set to the AC supply voltage and frequency applied. Note the permissible ranges of AC voltages and frequencies indicated at the rear of the instrument and in the data sheet.

② **ON/STANDBY key on the front panel**

The *ON/STANDBY* key at the front of the instrument determines whether the instrument is in standby mode or in operation.

Standby mode:
Only the OCXO reference frequency oscillator (option CMU-B11/B12), if installed, is supplied with operating voltage. The orange LED (STANDBY) is illuminated.

Operation:
The green LED (ON) is illuminated and all modules of the instrument are supplied with operating voltage.

☞ Chapter 1

The behavior of the CMU when it is switched off depends on the Front Module controller type installed; see Chapter 1.

... on Step 2

③ **Startup menu**

The startup menu displays the following information:

- The startup procedure (Process)
- Instrument model, serial number and version of the CMU base software (Info).
- Installed hardware and software options and equipment (Options). Available software options are listed with their version numbers.
- Progress of the startup procedure (Startup bar graph).

☞ Chapter 4

The *Default* hotkey can be used to load the factory default settings for all function groups. Settings made and stored in the previous session are overwritten.

④ **Wait hotkey**

By default the CMU switches to the last main menu of the previous session after terminating the startup process. This is convenient if an interrupted session is to be resumed or if the instrument is generally used in a definite operating mode.

On the other hand, the *Wait* function can be used to access the configuration menus which can be opened by means of the front panel keys before the actual measurement is started.

While the *Wait* hotkey is active, a reset of the instrument is not possible.

The CMU's user interface has been optimized with the aim of facilitating fast and easy switchover between the menus and measurement modes. This includes the general configurations which can be accessed from any measurement menu.

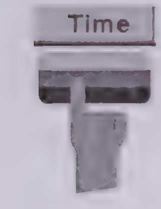
The most important selection and configuration menus such as *Reset, Setup, Menu Select* etc.are directly accessible via front panel keys.

⇓

Step 4

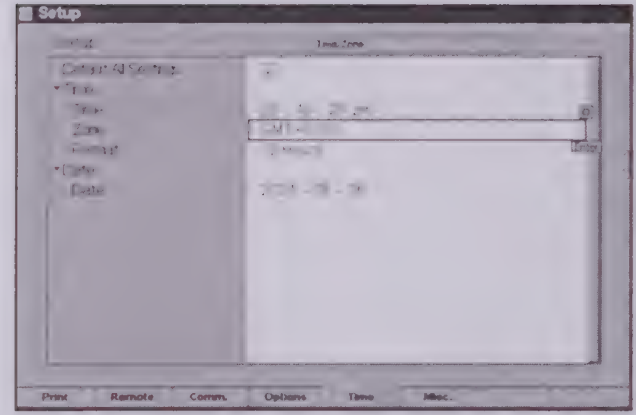
- Press the *SETUP* key to access general device settings.

⇓



- Press the *Time* hotkey to switch over to the *Time* tab of the *Setup* menu. ①

⇓



Step 5

The *Time* tab of the *Setup* menu displays the current time zone, time and date. ②

- Use the rotary knob to move the focus onto the *Time* section of the *Setup* table. If necessary, press the rotary knob or the *ON/OFF* key to expand the parameters in the table (see Chapter 3).
- Move to one of the input fields associated to the *Time* parameter, select with *ENTER* and use the rotary knob or the numeric keypad to correct the settings for the current time. Hours, minutes and seconds can be edited separately.
- Press *ENTER* to confirm the entries and quit the input fields.
- Move to *Zone* select field, activate with *ENTER*, and use the rotary knob to choose your own time zone.
- In the same way, activate the *Format* select field and use the rotary knob to switch over between European and North American time conventions.

Additional Information...

... on Step 4

① **Softkeys and hotkeys**
Softkeys and hotkeys are activated by pressing the associated keys on both sides and across the bottom of the display. The general purpose of softkeys is to provide settings, control the generator and the measurements. Hotkeys are used to switch over between different menus and different tabs belonging to a popup menu.

... on Step 5

② **Setup menu**

The *Setup* menu comprises several tabs providing general instrument settings. It is advisable to check and adjust the factory settings when you operate the CMU for the first time.

To switch over between the tabs of the setup menu use the hotkeys displayed at the bottom of the display.

Alternative Settings and Measurements

☞ Chapter 3

☞ Chapter 4

The different types of menus and control elements of the graphical user interface is explained in Chapter 3. In the same Chapter you can find a short tutorial on the entry of numbers and characters.

RF Non Signalling Measurements

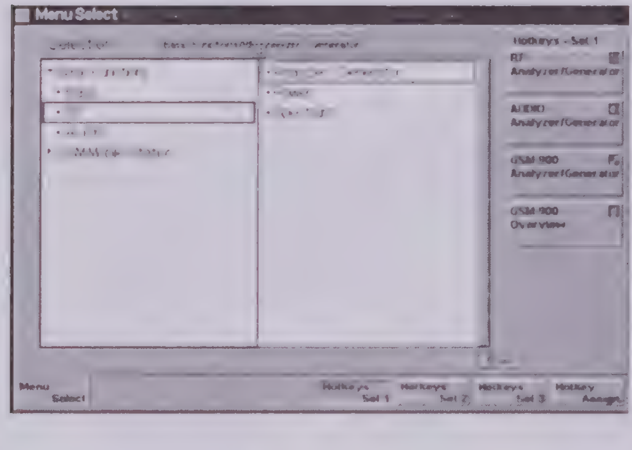
In the *RF Non Signalling* mode, a continuous or pulsed RF signal can be generated and a RF signal with definite frequency characteristics can be analyzed. The signal level can be plotted in oscillographical *(Power)* or spectral *(Spectrum)* representation.

Step 1

- ➢ Press the *Menu Select* key to open the *Menu Select* menu.①

MENU
SELECT

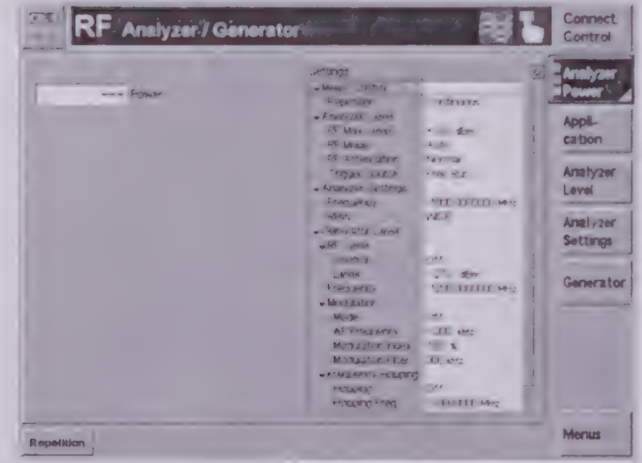
⇓


Menu Select
Hotkeys - Set 1
RF
Analyzer/Generator
AUDIO
Analyzer/Generator
GSM 900
Analyzer/Generator
GSM 900
Overview
Menu
Select
Hotkeys
Set 1
Hotkeys
Set 2
Hotkeys
Set 3
Hotkey
Assign.

- ➢ Use the cursor keys and the rotary knob to select the *RF* function group in the left half of the *Selection* table.
- ➢ In the right half of the table, select the *Analyzer/Generator* menu.
- ➢ Press the *Enter* key to activate the measurement selected and open the *RF Analyzer/Generator* menu.

⇓

Step 2


RF Analyzer / Generator
Connect
Control
Power
Analyzer
Power
Appli-
cation
Analyzer
Level
Analyzer
Settings
Generator
Repetition
Menus

In the *Settings* table the *Analyzer/Generator* menu indicates the parameters of the signal generated and those of the signal received and analyzed. ②

At present, all parameters have been reset to factory default values. Different softkey/hotkey combinations and popup menus are provided to change the settings. User-defined parameters will be saved for later sessions when the CMU is switched off.

The *Power* output field in the *Analyzer/Generator* menu shows an invalid result ("---") because at present no RF input signal is applied to the CMU.

⇓

Additional Information...

... on Step 1

① **Menu Select menu**

The *Menu Select* menu shows all function groups installed on your CMU. If a function group is selected the available test modes and measurement menus are indicated. Function groups representing digital network tests (such as *GSM400/850/900/1800/1900-MS)* are generally subdivided in the two test modes *Non Signalling* and *Signalling*, each containing a number of measurement menus.

The *RF* function group is available on any CMU regardless of the software options purchased. It comprises the three measurement menus *Analyzer/Generator*, *Power* and *Spectrum*. All three measurement menus are directly accessible from the *Menu Select* menu.

... on Step 2

② **Analyzer/Generator menu**

The *Analyzer/Generator* menu contains several softkeys to

- Control the RF signals received and analyzed *(Analyzer Level, Analyzer Settings*)
- Control the RF signals generated *(Generator*)

Defining a level and frequency via the *Generator* softkey and the associated hotkeys implies that a continuous signal (CW) with this level and frequency is generated.

The *RF Max. Level* defined via *Analyzer Level*, however, denotes the maximum input power which can be measured. This is identical with the upper edge of the *Power* diagram (see below). The permissible range of *Max. Level* depends on the input connector and external attenuation used (see section *Analyzer Settings* in Chapter 4).

Defining a (center) *Analyzer Settings – Frequency* implies that only signals around this frequency are analyzed.

The *Analyzer Settings – RBW* hotkey defines the resolution bandwidth of the analyzer.

③ The status of the *Analyzer Power* measurement is shown in the corresponding softkey. For ongoing measurements, the result in the *Power* output field is constantly updated.

At present no input signal is available so that the *Power* output field shows an invalid result "– – –"

Once the softkey is selected, the *Analyzer Power* measurement can be switched off and on by means of the *ON/OFF* key. In contrast, the *CONT/HALT* toggle key halts the measurement after the next valid result has been obtained.

Alternative Settings and Measurements

☞ Chapter 4

For digital network tests refer to the relevant operating manuals. e.g. *GSM400/850/900/1800/1900-MS.*

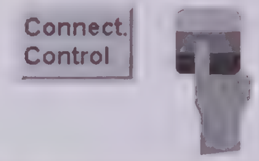
☞ Chapter 4

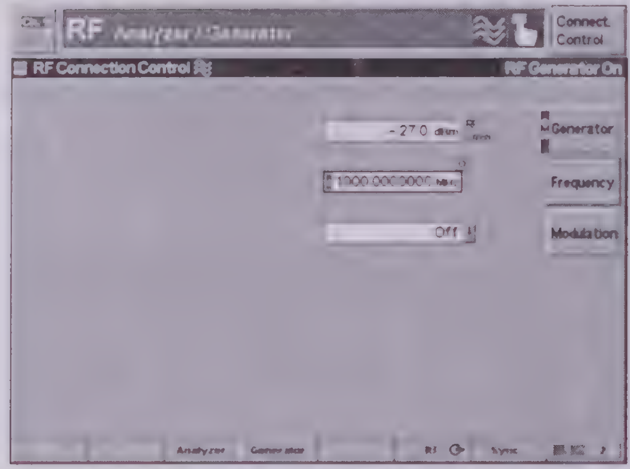
The *Generator* softkey provides the most important settings of the *Generator* tab of the *Connection Control* menu.

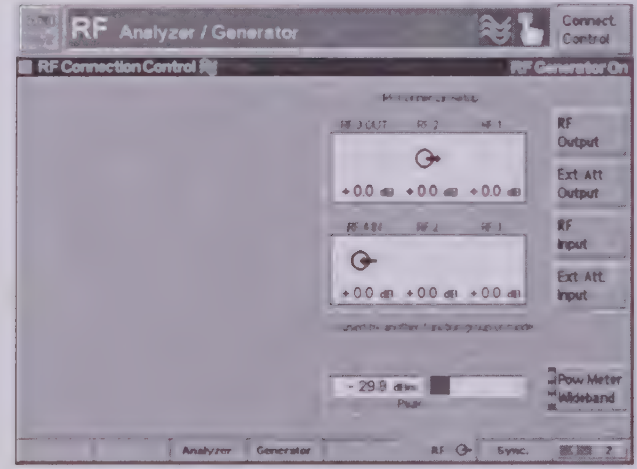
The *Analyzer Level* and *Analyzer Settings* softkeys correspond to the *Analyzer* tab of the *Connection Control* menu.

☞ Ch. 4 and Ch. 5

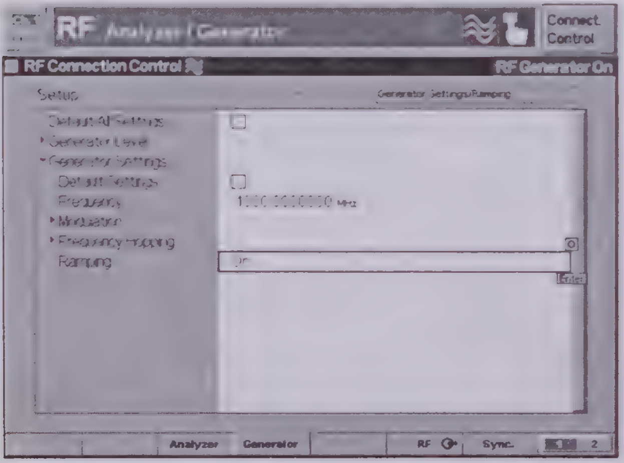
The options for the measurement status are *ON, OFF, or HLT*. The *HLT* state is reached after the end of a single shot measurement (see the section about measurement control in Chapter 5).


Connect.
Control


RF Analyzer / Generator
Connect. Control
RF Connection Control
RF Generator On
-27.0 dBm
1000.000000 MHz
Off
Generator
Frequency
Modulation
Analyzer
Generator
RF
Sync.


RF Analyzer / Generator
Connect. Control
RF Connection Control
RF Generator On
RF Output
Ext Att Output
RF Input
Ext Att Input
+0.0 dB
+0.0 dB
+0.0 dB
+0.0 dB
+0.0 dB
+0.0 dB
-29.9 dBm
Peak
Pow Meter Wideband
Analyzer
Generator
RF
Sync.
2

⇓


RF Analyzer / Generator
Connect. Control
RF Connection Control
RF Generator On
Setup
Generator Settings/Ramping
Default All Settings
Generator Level
Generator Settings
Default Settings
Frequency
Modulation
Frequency Hopping
Ramping
1000.000000 MHz
On
Enter
Analyzer
Generator
RF
Sync.
2

Step 3

- Press the *Connect. Control* softkey and use the *Generator* hotkey to open the *Generator* tab. ①

The *Generator* tab controls the RF generator and defines the *Frequency* and *Modulation* of the generated RF signal.

- Select the *Generator* softkey by pressing once.
- Press the *ON/OFF* key to switch the RF generator on. ③
- Set the generator frequency equal to the default frequency of the RF analyzer frequency as shown in the figure.
- Press the *RF* ⊶ hotkey to open the tab defining the signal connectors and external attenuation.
- Select RF2 as output connector, RF4 IN as input connector. Do not define any external attenuation (all values equal to 0.0 dB).

Two yellow LEDs on the front panel indicate the input and output connectors selected.

- Use a coax cable to connect RF2 to RF4 IN.
- Press the *ESCAPE* key to close the popup menu and return to the *RF Analyzer/Generator* main menu.

The RF level measured is now indicated next to the *Analyzer Power* softkey. Due to the loss in the signal path it should be slightly below the generator power selected. ②

- Reopen the *Connection Control* menu and press the *Generator* softkey twice.

The table-oriented version of the *Generator* tab is opened.

- Press *ON/OFF* to expand the parameter tree, use the rotary knob to select the *Ramping* parameter, press *Enter* and use the rotary knob again to switch the power ramping *ON*.

Now the generator transmits a pulsed (instead of a continuous) signal.

- Press the *Connect. Control* softkey again or the *ESCAPE* key to close the popup menu.

Additional Information...

... on Step 3

① **RF connectors**

The *RF Connection Control* menu configures the input and output connectors in the *RF* function group. The four connectors on the front panel differ by their permissible range of input and output powers (see Chapter 4 and data sheet). The values quoted on the left side are compatible with the rated specifications.

② **External attenuation**

An external attenuation can be reported to the CMU in order to compensate for known losses between the signal source and the device under test or the analyzer.

In our example, the (positive) difference between the analyzer power measured and the generator power can be reported as an external output attenuation at RF 2. The RF generator increases its level to maintain the commanded power of –27 dBm at the analyzer. The nominal generator power set in the RF level field is thus measured and indicated next to the *Analyzer Power* softkey.

Note: RF User Correction

In addition to the static external attenuation settings, the CMU provides a systematic correction of the generated and measured RF power by means of user-defined, frequency and level-dependent correction tables; see section RF User Correction *in Chapter 1.*

Alternative Settings and Measurements

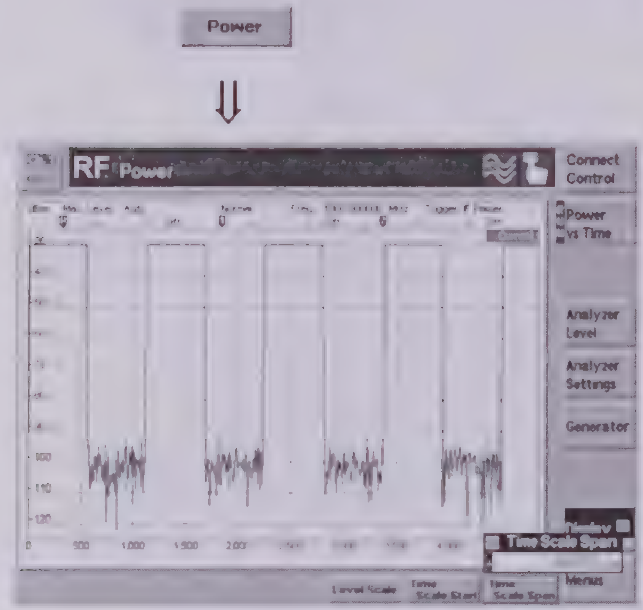
☞ Chapter 4

Settings made in the *Connect. Control* menus apply to the entire function group *RF Non Signalling*.

☞ Chapter 4

Note that an external attenuation reported to the CMU shifts the nominal permissible ranges of input and output levels.

Step 4


Power
RF Power
Connect Control
Power vs Time
Analyzer Level
Analyzer Settings
Generator
Display
Time Scale Span
Level Scale
Time Scale Start
Time Scale Span
Menus

- ➢ Press the *Power* hotkey to switch over to the graphical menu *Power*.

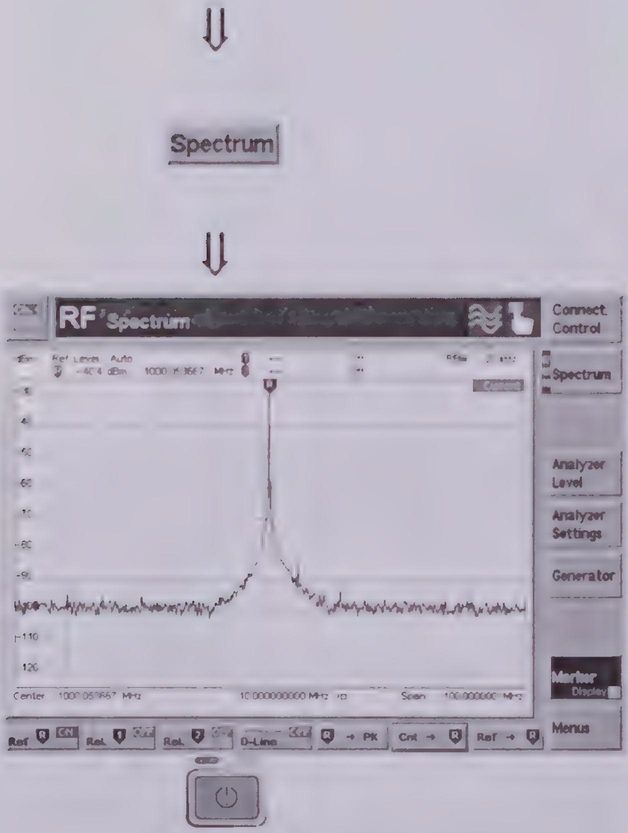
The *Power* menu shows the RF signal power measured as a function of time at a particular frequency and resolution bandwidth. An appropriate trigger condition must be selected to obtain a stable display. ①

Settings (default settings or the ones made in the *Analyzer/Generator* menu) and scalar results are displayed in two parameter lines above the diagram.

Various tools allowing to take a closer look at the measurement results are provided in the graphical measurement menu. ②

- ➢ Press the *Marker/Display* softkey twice and vary the *Time Scale* to display several pulses in the diagram.
- ➢ Press the *Analyzer Settings* softkey and vary the resolution bandwidth (hotkey *RBW*). ③
- ➢ Press the *Menu* softkey to display the hotkeys used to change over to the other measurement menus.
- ➢ Press the *Spectrum* hotkey to switch over to the graphical menu *Spectrum*.

Step 5


Spectrum
RF Spectrum
Connect Control
Spectrum
Analyzer Level
Analyzer Settings
Generator
Marker Display
Menus
Center 1000.050667 MHz
Span 100.000000 MHz
Ref
Rel.
Rel.
D-Line
→ PK
Cnt →
Ref →

The *Spectrum* menu shows the signal power in spectral representation, i.e. as a function of the frequency.

The settings and results displayed in the two parameter lines above the diagram are analogous to the ones shown in the *Power* menu.

- ➢ Press the *Marker* softkey and use the *R to Pk* and the *Cnt to R* hotkeys to center the diagram. ④
- ➢ Press the *Analyzer Settings* softkey to scale the diagram and adjust the resolution bandwidth.
- ➢ To close your session set the CMU to standby mode using the power switch on the front panel or use the mains switch at the rear.

Additional Information...

... on Step 4

① **Trigger mode**

The trigger mode is set in the *Analyzer* tab of the *Connection Control* menu or via the *Trigger* softkey in the graphical measurement menus. With the default setting *Free Run* the measurement is not synchronized to the frequency of the incoming pulses: The trace is permanently shifted in horizontal direction.

To show a signal consisting of rectangular pulses (bursts) it is recommended to trigger by either the rising or falling edge of the IF power.

② **Markers**

Markers are a graphical tool used to locate points on a trace and read out their coordinates. A reference marker and two delta markers may be defined in the *Power* menu.

The reference marker R measures the absolute level of the trace, the delta markers 1 and 2 measure the distance between their position and the reference marker. All marker coordinates are shown in the two parameter lines above the diagram.

③ **Resolution bandwidth**

A spectrum analyzer can differentiate two spectral lines separated by a minimum distance corresponding to the bandwidth of the resolution filter.

The smaller the bandwidth the better the resolution and the larger the signal-to-noise ratio. If the resolution bandwidth is too large only the envelope of the spectrum can be measured.

In the *Power* measurement, the signal-to-noise ratio improves but the time resolution **deteriorates** when the resolution bandwidth is reduced.

... on Step 5

④ **Scaling of the spectral diagram**

The tools provided in the *Spectrum* menu are particularly suitable for scaling a spectral diagram with a sharp main lobe and symmetric, lower side lobes:

- The *R to Pk* hotkey (*Marker* softkey) places the reference marker to the maximum (i.e. the main lobe) of the diagram.
- The *Cnt to R* hotkey (*Marker* softkey) centers the diagram to the frequency of the main marker.
- Equivalently, the *Center* hotkey *(Frequency/RBW* softkey) can be used to center the diagram.

Alternative Settings and Measurements

☞ Chapter 4

The *Frequency* softkey defines the frequency of the measured signal and the resolution bandwidth. The *Input Level* softkey configures the input level, the power range and an attenuation factor. The *Time* softkey configures the time axis.

☞ Chapter 4

In addition to markers, a D-line can be used to measure a particular level in the diagram.

☞ Chapter 4

☞ Chapter 4

Contents

3 Manual Operation 3.1

Controls 3.1
  Rotary Knob 3.2
  Front Panel Keys 3.2
  Softkeys 3.2
  Hotkeys 3.3

Operating Menus 3.4
  Measurement Menus 3.4
  Graphical Measurement Menus 3.7
  Popup Menus 3.8
    Operation of Popup Menus 3.9

Dialog Elements in the Menu 3.10
  Input Fields 3.10
    Input of Numbers 3.10
    Input of alphanumerical characters 3.12
  Select Fields in Popup Menus 3.14

Measurement Control 3.16
  Configurations 3.16
  Measurement Groups 3.17
  General Settings 3.18

3 Manual Operation

This chapter provides a survey of the CMU's operating concept. This includes a description of the basic menu types, the selection and setting of parameters, and a general discussion of measurement control. The operating menus in the CMU basic system, the *RF* function group, and optional function groups are presented in an overview at the end of this chapter and described in greater detail in Chapter 4.

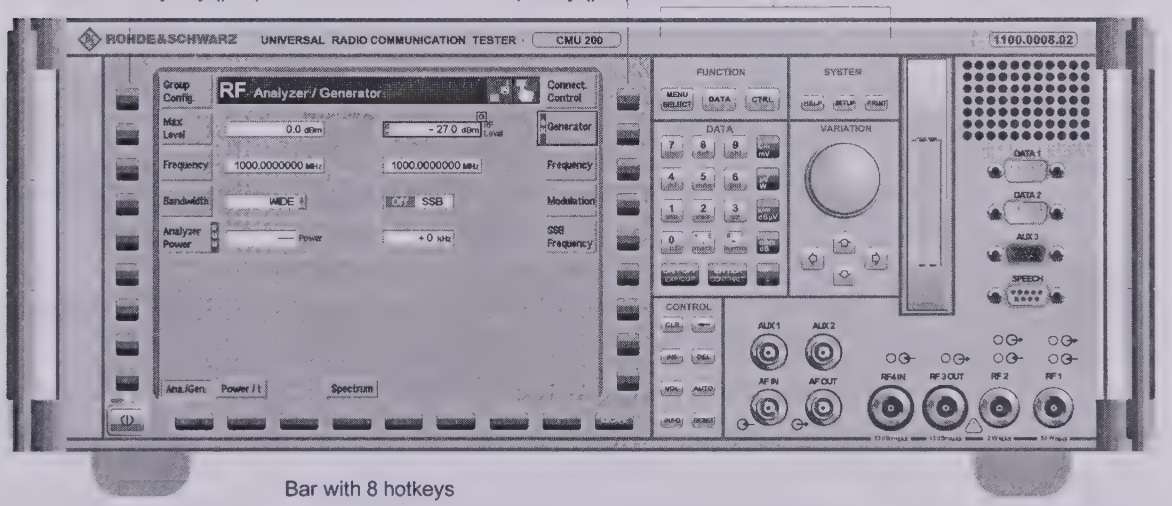
Operating concept The CMU was designed for easy, intuitive operation. All menus rely upon a limited number of controls with analogous or identical function. Basic settings are discussed in section *Measurement Control* on page 3.16 and in Chapter 5.

Basic elements The CMU is operated via softkeys and tables. Softkeys provide a fast access to the instrument functions. Tables facilitate the management of larger amounts of data.

Flexibility and uniformity The CMU permits to switch over between various operating modes (multi-mode operation). For this purpose, it is possible to change between the menus in almost any instrument state. The different function groups (*RF, GSMxxx-MS* etc., see also separate operating manuals for network test applications) can be operated in the same way; measurements of the same type belonging to different applications are standardized.

Controls

The CMU is operated under menu control via keys, softkeys and hotkeys:


ROHDE&SCHWARZ
UNIVERSAL RADIO COMMUNICATION TESTER
CMU 200
1100.0008.02
RF Analyzer / Generator
Group Config.
Max Level
Frequency
Bandwidth
Analyzer Power
Connect. Control
Generator
Frequency
Modulation
SSB Frequency
Anal./Gen.
Power / t
Spectrum
FUNCTION
MENU SELECT
DATA
CTRL
SYSTEM
HELP
SETUP
PRINT
DATA
VARIATION
CONTROL
DATA 1
DATA 2
AUX 3
SPEECH
AUX 1
AUX 2
AF IN
AF OUT
RF4 IN
RF 3 OUT
RF 2
RF 1

9 softkeys with alternating function, ON/Standby key (p. 4)

9 softkeys with alternating function, Escape key (p. 4)

Keypad

Bar with 8 hotkeys

Fig. 3-1 Keys, softkeys and hotkeys

Rotary Knob

The rotary knob (spinwheel) can be used in two different ways:

- It is **turned** to select entries in list fields and tables and to vary (increment/decrement) numerical and alphanumerical entries.
- It is **pressed** to expand or compress table sections (thus replacing the *ON/OFF* key), to expand pull-down lists, to open auxiliary input fields, and to confirm numerical entries or selections (thus replacing the *ENTER* key).

Front Panel Keys

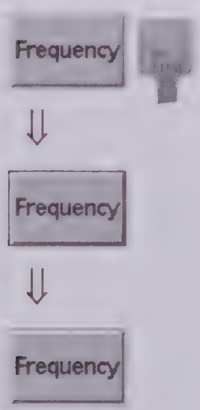
The keys located in the right-hand part of the front panel are combined to form groups according to their functions. They control

- Data input and variation
- Pre-selection of the menus
- Settings of the instrument, editor, help file and output

The keys are described with their function in Chapter 1, section *Front and Rear View*.

Softkeys

Softkeys are assigned to the nine keys located both at the left and at the right edge of the screen. To simplify the display, only the softkeys which are actually assigned in a menu are indicated (see menu example in *Fig. 3-1*).



Selection of softkeys:

The CMU provides selectable and non-selectable softkeys. A softkey is selected by pressing the associated key.

A selected softkey is highlighted by a blue frame. Softkey selection establishes a connection to settings and functions related to the softkey. These related functions can be initiated via keys (e.g. *ON/OFF*, *CONT/HALT*), or via the selected softkey itself (e.g. calling up popup menus by pressing a selected softkey again).

After the function has been terminated, or after another softkey is selected, the softkey returns to its initial state.

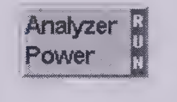
Softkey types and their function:

Softkeys perform definite tasks within the corresponding menus. Different types of softkeys are provided:

Group
Config.

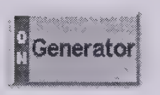
- Pressing the softkey (i.e. the associated key) causes an immediate response on the screen. Examples are the non-selectable softkeys *Group Config.* and *Connect. Control* used to call up popup menus.

- Pressing the softkey activates a dialog box, e.g. an input field.



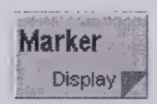
- The softkey is a measurement control softkey (main softkey) indicating the measurement state (*RUN, OFF, HLT*). A yellow triangle indicates that a popup menu providing configurations can be opened with the softkey (press once for selection, a second time for opening the popup).

  A measurement can be started and aborted with the *ON/OFF* key (i.e. the ON/OFF key switches between the measurement states *RUN* and *OFF*). It can be stopped while preserving the valid results with the *CONT/HALT* key (i.e. the *CONT/HALT* key switches between the measurement states *RUN* and *HLT;* starting a measurement from the *OFF* state by means of the *CONT/HALT* key is not possible). In the *HLT* state, the instrument resources are not released; the application is still available. The formal aspects of measurement control are explained in Chapter 5.



- The softkey indicates the generator status *(ON, OFF)*. A yellow triangle indicates that a popup menu providing configurations can be opened with the softkey (press once for selection, a second time for opening the popup).

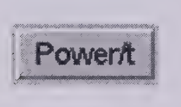
  A generator can be started and aborted with the *ON/OFF* key. The formal aspects of generator control are explained in Chapter 5, section *Measurement Control*.

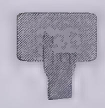


The softkey toggles between two hotkey bars (corresponding to two groups of settings). The current group is indicated in large typeface in the first line of the softkey; the alternative group appears in smaller typeface next to a double triangle.

Hotkeys

Hotkeys are assigned to the eight keys at the lower edge of the screen. Only the hotkeys softkeys which are actually assigned in a menu are indicated (see *Fig. 3-1*).





Selection:

A hotkey is activated by pressing the associated key. After activation it changes its frame.

Function:

Hotkeys permit to

- Change from one measurement menu/graphical measurement menu to the other

- Select tabs in the popup menu
- A yellow triangle indicates that a second version of the current tab providing additional configurations can be opened with the hotkey. The hotkey toggles between the two versions of the tab.

In the graphical measurement menu (see page 3.7), hotkeys provide extended settings and can be used like ordinary function softkeys.

Operating Menus

The CMU offers a large variety of operating modes and applications. To ensure quick and easy operation, uniform menus have been implemented. They can be divided into three types:

Measurement menu	Offers the most important settings controlling a measurement and displays the main results.
Popup menu	Provides extended settings for a measurement menu or function group.
Graphical menu	Displays a measurement trace together with settings and further measurement results, contains softkeys and hotkeys used to access measurement control settings.

Measurement Menus

A measurement menu provides the basic settings controlling a measurement and at the same time displays the main results. Together with the graphical measurement menus, measurement menus constitute the basic level in the operating system of the CMU. They can only be replaced by other measurement menus or graphical measurement menus. To change the menu, the hotkeys at the lower edge of the measurement menu are used.

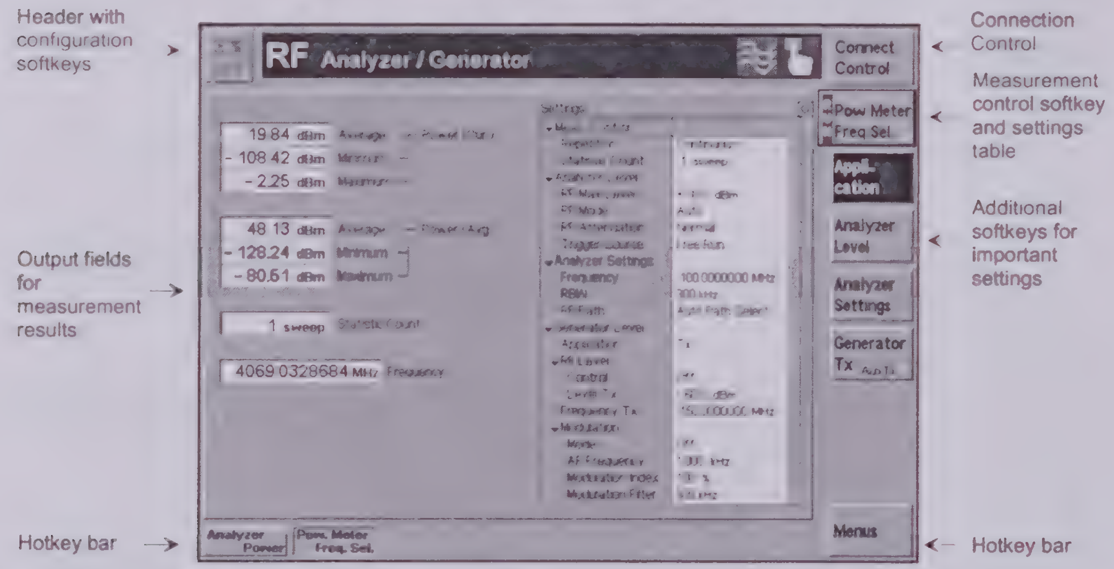

Header with configuration softkeys
Output fields for measurement results
Hotkey bar
Connection Control
Measurement control softkey and settings table
Additional softkeys for important settings
Hotkey bar
RF Analyzer / Generator
Connect Control
Pow Meter
Freq Sel
Appli-cation
Analyzer Level
Analyzer Settings
Generator Tx
Menus
Analyzer Power
Pow. Meter Freq. Sel.
19.84 dBm
- 108.42 dBm
- 2.25 dBm
48.13 dBm
- 128.24 dBm Minimum
- 80.61 dBm Maximum
1 sweep
4069.0328684 MHz
Analyzer Settings
Frequency
RBW
100.0000000 MHz

Fig. 3-2 Example of a measurement menu

Header The header consists of the heading and the symbols for the operating mode and test mode (signalling state, if applicable in the function group).

- The *heading* briefly describes the purpose of the menu (e.g. type of settings, measurement group, function group, etc.).
- The *operating mode*, i.e. the type of operation/control of the CMU, is indicated by the symbols at the right edge of the header. The following operating modes are available:

Manual mode

Remote control via IEC-bus

- The *function group* is indicated to the left of the operating mode:

RF measurements

Audio Analyzer and Generator (with option CMU-B41)

In network test applications, the *signalling states* that are specific to the applications are indicated. The corresponding icons are discussed in the relevant manuals (see *GSMxxx-MS* etc.).

General settings

Connect.
Control

The *Connect. Control* softkey is located to the right of the header of each measurement or graphical measurement menu. This softkey opens a popup menu defining the input and output connectors, the external attenuation, the reference frequency as well as many network-specific settings.

In the *Signalling* test modes of many network options, the *Connection Control* menu is also used to set up and terminate a connection between the CMU and the DUT.

The *Connection Control* menu also contains the input path and the trigger settings for the current function group and signalling state.

Measurement control softkey

Pow.Meter
Freq.Sel.

The measurement control softkey (main softkey) controls the measurement application and indicates its state *(RUN | HLT | OFF);* see section *Softkeys* on p. 3.1 ff. Its labeling corresponds to the menu heading. For large measurement groups that are subdivided into several applications, the labeling indicates the current application.

The hotkey bar associated to the measurement control softkey provides parameters to define the scope of the measurement (statistical settings).

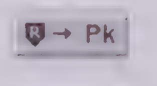
Pressing the measurement control softkey twice opens a popup menu providing measurement-specific settings.

Softkeys for important settings

The softkeys below the measurement control softkey provide groups of important measurement settings. Each softkey activates an associated hotkey bar. An active softkey is displayed in inverse video.

The *Menus* softkey displays all measurements in the function group, so it is possible to change from one measurement to another.

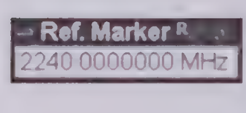
Hotkeys



If one of the softkeys is activated, the hotkeys below the test diagram provide sub-functions for this softkey.

If the Menus softkey is activated, the hotkeys change between the various measurement groups of the current function group.

Popup box



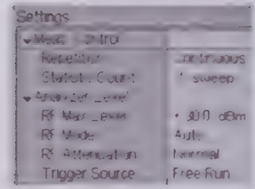
Ref. Marker R

2240.0000000 MHz

Popup boxes are associated to all hotkeys that require a selection or input of parameters. These popup boxes are operated like input fields in the measurement menus (input of numbers and characters) or list fields (selection from a range of alternative settings).

Popup boxes are closed when the calling hotkey is pressed again or when another popup box is opened. They remain open when another softkey is selected, so it is possible to easily test the effect of repeated changes of a parameter.

Settings table



Settings

Meas. Control	
Repetition	Continuous
Statist. Count	1 Sweep
Analyzer Level	
RF Max Level	+30.0 dBm
RF Mode	Auto
RF Attenuation	Normal
Trigger Source	Free Run

The *Settings* table in the right half of the menu gives an overview of the current measurement settings. The entries vary with the measurement and measurement applications. The rotary knob scrolls and expands the *Settings* table.

Graphical Measurement Menus

The CMU displays arrays of measurement results in the form of two-dimensional diagrams. In order to obtain additional space for the test diagram, no settings table is displayed. The header and the functionality of the softkeys and associated hotkeys is identical to the measurement menu; see section *Measurement Menus* on page 3.4.

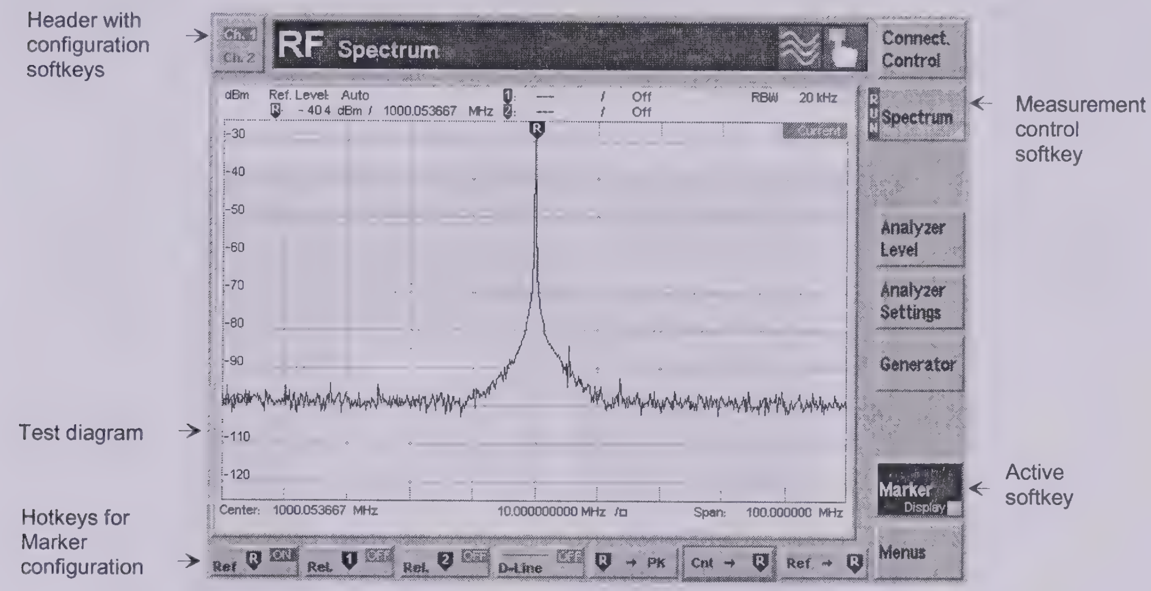
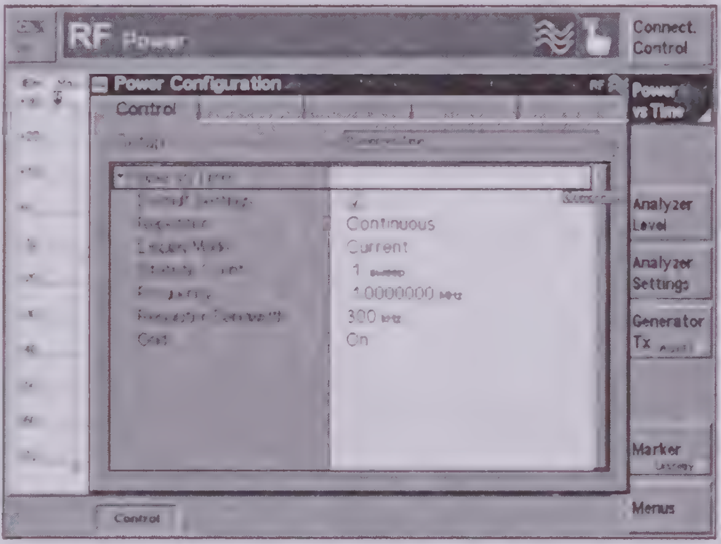

Header with configuration softkeys
Test diagram
Hotkeys for Marker configuration
Measurement control softkey
Active softkey
Ch. 1
Ch. 2
RF Spectrum
Connect. Control
RUN
Spectrum
Analyzer Level
Analyzer Settings
Generator
Marker
Display
Menus
dBm
Ref. Level: Auto
R: -40.4 dBm / 1000.053667 MHz
1: --- / Off
2: --- / Off
RBW 20 kHz
Current
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
Center: 1000.053667 MHz
10.000000000 MHz /□
Span: 100.000000 MHz
Ref R ON
Rel. 1 OFF
Rel. 2 OFF
D-Line OFF
R → PK
Cnt → R
Ref → R

Fig. 3-3 Example of graphical measurement menu

Popup Menus

Popup menus extend the functionality of a measurement menu. They are assigned to the configuration softkey *Connect. Control* as well as to all measurement control softkeys in a measurement menu that are marked by a yellow triangle at the bottom right. They may be divided into several tabs that are selected via hotkeys in the measurement menu.

The popup menu *Connection Control* is activated by pressing the associated softkeys. Popup menus which configure a measurement are activated by pressing the measurement control softkey twice (selection of softkey and subsequent opening of popup menu). A popup menu is closed by means of the *ESCAPE* key or by pressing the calling softkey again.



Popup menu with Header and two tabs

Calling softkey, press twice

Hotkeys for selecting the tabs

Fig. 3-4 Example of a popup menu

Header The header consists of

- The heading (*<name of the measurement group> Configuration*; the function group is indicated on the right in small characters),
- The symbol for the signalling state on the right. See section *Measurement Menus* on page 3.4.

Tabs Popup menus come without tabs (1 single window) or with several tabs.

The tabs may contain input fields, select fields, command and on/off switches (check boxes). Various fields can be combined to form groups (panels).

(Expanding) menu tables Configuration settings in popup menus are often arranged in tables. If a table provides a large number of settings, these are usually grouped under several header lines marked by a black triangle. The items belonging to a group can be shown (expanded, triangle points down) and hidden (compressed, triangle points to the right) by selecting the corresponding header line and pressing the *ON/OFF* key or the rotary knob.

Operation of Popup Menus

The following table provides an overview of the operation of popup menus.

Table 3-1 Operation of popup menus

Action		**Operation via keys**
Open menu		Press the softkey twice (selection plus opening of menu), press only once in the case of *Connect. Control*
Select	tabs dialog elements	Press hotkey softkeys *(Connect. Control)*, cursor keys ⇦⇨⇧⇩
Edit fields		Keys *ON/OFF, ENTER,* number and unit keys, rotary knob, see section *Dialog Elements in the Menu* on page 3.10.
Edit table entries		Keys ON/OFF, ENTER, number and unit keys, rotary knob, see section *Dialog Elements in the Menu* on page 3.10.
Quit and close menu		Any assigned softkey / *ESCAPE* key

Dialog Elements in the Menu

This section describes the various types of dialog fields and the procedure for the input of values and parameters.

In many input or select field types, a selection made must be confirmed using the *ENTER* key. The cursor can be freely shifted over these fields, only after confirmation is the setting transferred to the instrument software.

In the case of select fields without confirmation, settings take effect immediately with the cursor selection.

Input Fields

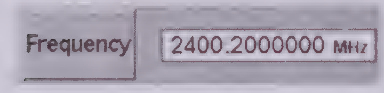
An input field (editor) is a white, rectangular area on the screen which permits numbers or characters to be entered. Input fields are available both in measurement and in popup menus. In graphical measurement menus, the input fields are popup windows which can be called up by means of hotkeys while the instrument is in the function mode.

Note: *The easiest and quickest way to enter numbers or characters is by means of an external keyboard that is connected to the* KEYBOARD *connector at the rear of the CMU (see Chapter 1). Alternatively, follow the directions given in the next two sections.*

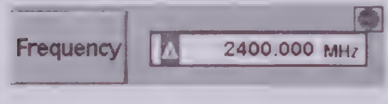
Input of Numbers

Input fields for numerical values are activated by pressing the respective softkey. Numerical values can either be varied using the rotary knob (by incrementing/decrementing individual digits) or directly entered via the numerical keypad *(DATA)* on the front panel or an external keyboard. To this end, the insert and overwrite mode is available. It may be necessary to confirm the input for transfer to the instrument hardware.

In the following, the most important possible inputs using the rotary knob or the numerical keys will be described.



Frequency 2400.2000000 MHz



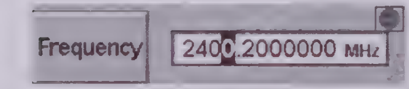
Frequency 2400.000 MHz

Activating an input field and a digit

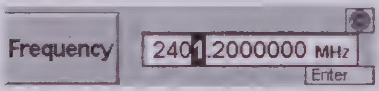
- To activate the input field press the associated softkey.

  The input field appears with a blue frame. The symbol for the rotary knob appears at the top right of the input field.

  The input field is in start mode, indicated by a small white triangle on a gray background. From the start mode, it can be switched to either insert or overwrite mode.



Frequency 2400.2000000 MHz



Frequency 2401.2000000 MHz

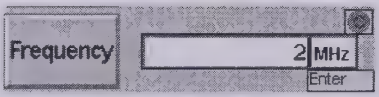
Input using the rotary knob – Overwrite mode

- In the start mode, turn the rotary knob to activate the overwrite mode and vary the last digit of the current number.
- Use the left or right *cursor key* to switch between the decimal places of the indicated number.
- Increment/decrement the active digit by turning the *rotary knob.*

  The individual digits can be varied without restriction. Incrementing a "9" produces 0 and causes the next higher digit to be incremented by 1. The editor behaves analogously when a “0“ is decremented.

An *Enter* symbol at the bottom right of the input field indicates that the current value has yet to be written to the CMU software.

- Confirm the entry and terminate the input using the *ENTER* key or by pressing the rotary knob or another softkey or ...
- Press *ESCAPE* to discard the entry.



Input using the numerical keypad – Insert Mode

- In the start mode, type one of the number keys of the numerical keypad.

  The previous numeric value of the editor is completely replaced. The CMU changes to the insert mode characterized by a cursor symbol. Further digits are inserted to the left of the cursor.
- Entries made in insert mode via the numerical keypad must always be confirmed using the *ENTER* key or by pressing the rotary knob.

Further control keys

The keys of the *CONTROL* group extend the functions of numerical input.

- Use the INS *(insert)* key to change between the modes *insert* and *overwrite*.

  In the insert mode, the cursor appears in the input field.
- Use the ← *(backspace)* key to delete the character to the left of the cursor (in insert mode).
- Use the DEL *(delete)* key to delete the highlighted character (in overwrite mode) and the digit right from the cursor key (in insert mode).
- Use the CLR *(clear)* key to delete all characters.

Confirming/discarding the input

The behavior of the editors depends on whether the values were entered in the insert or in the overwrite mode:

- If only the overwrite mode was used to define the input value no confirmation is necessary. The input value is valid as soon as another softkey or hotkey is pressed.
- If the insert mode is used, or if it was used before swapping over to the overwrite mode, the input must be confirmed with the *ENTER* key or by pressing the rotary knob. By pressing *ESCAPE* or another softkey, the input will be discarded and the previous value restored.

If the number entered conflicts with the resolution of the CMU, it will be rounded to the maximum number of digits allowed.

Error message during input

If the value defined in the input field is too high or too low, a window with the error message „*<numerical value> is out of range. <permissible maximum value> is limit.*“ will appear together with three buttons:

Accept	Permissible maximum value accepted for input field,
Re-edit	New entry
Cancel	Last valid input value is retained.

Input of alphanumerical characters

Input fields for alphanumerical characters are activated by pressing the respective softkey. Characters can be either varied using the rotary knob (by variation of individual characters in alphabetical order) or entered via the numerical keypad *(DATA)* on the front panel or an external keyboard. The input must be confirmed using the *ENTER* key in order to be transferred to the instrument hardware. The input is terminated upon confirmation.

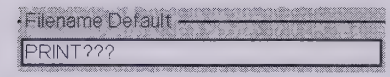
The table below shows the assignment of the numerical keys.

Table 3-2 Assignment of numerical keys and alphanumeric characters

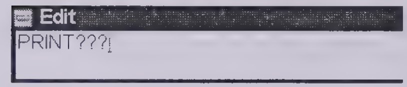
Key	**Character (upper case)**	**Character (lower case)**
7 abc	A B C 7 Ä Æ Å Ç	a b c 7 ä æ å ç
8 def	D E F 8 É	d e f 8 é e
9 ghi	G H I 9	g h i 9 i
4 jkl	J K L 4	j k l 4
5 mno	M N O 5 Ñ Ö	m n o 5 ñ ö ò
6 pqr	P Q R 6	p q r 6 ß
1 stu	S T U 1 Ü	s t u 1 ü ù
2 vwx	V W X 2	v w x 2
3 yz	Y Z 3	y z 3
0 µΩ	space µ Ω 0 £ $ ¥ €	space µΩ 0 £ $ ¥ €
. * mark	\ _ * , . : ; ' " ? ( )	\ _ * , . : ; ' " ? ( )
- # symb	- # / ( ) < = > % &	- # / ( ) < = > % &
UNIT.. ⇩	Upper / lower case	Upper / lower case

The full character set may be restricted if required for reasons of compatibility (e.g. for input fields defining file names).

The most important possible inputs using the rotary knob or the digital keys are described in the following.



PRINT???



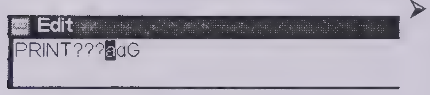
PRINT???

Activating the input field and auxiliary editor

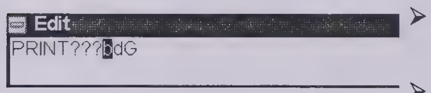
- ➢ To activate the input field press the associated softkey. If the softkey is assigned to a panel with several controls, use the cursor key to select the desired input field.
- ➢ Press or turn the rotary knob to open the auxiliary editor associated to the input field.

  The auxiliary editor is used to edit a name that may extend over several lines. The cursor is placed at the end of the current character string.

PRINT???adG



PRINT???adG



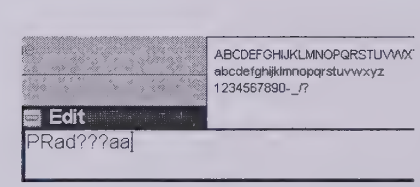
PRINT???bdG

Input using the numerical keys

- ➢ Press one of the numerical keys to write a character to the current cursor position.
- ➢ To change a character, position the cursor to the desired character using the left or right *cursor key* and overwrite the character.
- ➢ Press a numerical key repeatedly to access the different characters assigned to it (see assignment of keys in *Table 3-2*).
- ➢ Press the *UNIT* key plus a numerical key to switch to the upper case character set.
- ➢ Confirm the input using the *ENTER* key.

  If the syntax specified is invalid (e.g. an invalid file name was defined), an error message of the type *Filename syntax <name> is invalid Cancel / Re-edit* is displayed. Otherwise the edited character string is written to the input field in the menu.

- ➢ Press another softkey or change the menu to close the auxiliary editor.



ABCDEFGHIJKLMNOPQRSTUVWX
abcdefghijklmnopqrstuvwxyz
1234567890-_/?
PRad???aa

Input using the rotary knob

- ➢ After opening the auxiliary editor, turn the rotary knob in either direction. A list of all valid (upper and lower case) characters for the current input field is opened.
- ➢ Turn the rotary knob and select the character to be written to the cursor position in the auxiliary editor. Selected characters are shown in inverse video.
- ➢ Press the rotary knob to confirm your selection and enter the selected character into the auxiliary editor.
- ➢ Select a character and turn the rotary knob to increment/decrement the character in alphabetical order.

Insert/overwrite

The keys of the *CONTROL* group extend the functions of character input.

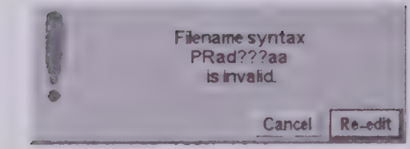
- ➢ Use the INS *(insert)* key to change between the modes *insert* and *delete*.

In insert mode, the cursor appears in the input field.

- Use the ← *(backspace)* key to delete the character to the left of the cursor.
- Use the DEL *(delete)* key to delete the inversely displayed character (in overwrite mode).
- Use the CLR *(clear)* key to delete all characters.

Confirming/discarding the input

- Use the *(ESCAPE)* key or another softkey to abort character input and deactivate the input field and the softkey.
- Use the *(ENTER)* key to confirm the character input.


Filename syntax
PRad???aa
is invalid.

If the syntax specified is invalid (e.g. an invalid file name was defined), an error message of the type *Filename syntax <name> is invalid Cancel / Re-edit* is displayed. Otherwise the edited character string is written to the input field in the menu.

- Press another softkey or change the menu to close the auxiliary editor.

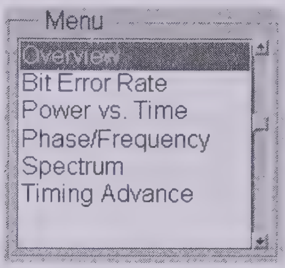
Select Fields in Popup Menus

Various types of fields permit to select one or several settings out of a number of given options. The desired settings are to be marked; the selection is to be confirmed using the *ENTER* key, if required.

Popup menus may or may not contain softkeys; they contain input or select fields which can be combined to form panels or groups and tables. Select fields and tables in the popup menus can be controlled intuitively using the cursor keys ⇦ ⇨ ⇧ ⇩. The following overview applies to all field types.

Table 3-3 Operation of select fields

Action	**Key operation**
Select field group / list	Cursor keys, softkey
Select single field, command button, or line in list field or table	Rotary knob
Switch on or off single field or line in list field	*On/Off* key, in the case of buttons also rotary knob, *ENTER* key
Confirmation (if required)	*ENTER* key

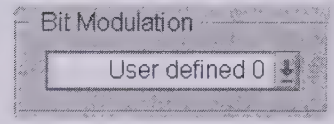


List fields (selection 1 out of n)

provide a choice of several text lines in a rectangular window:

- ➢ Select one out of several list fields using the cursor keys.
- ➢ To select a line use the rotary knob. If a line beyond the edge of the list is to be selected, the whole list will be shifted (scroll function).

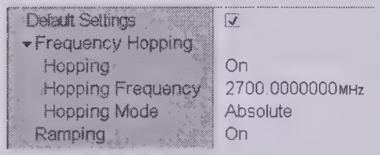
For operation of list fields see *Table 3-3*.


Bit Modulation: User defined 0

Pull-down list fields

are similar to the list fields described above as far as their function and operation is concerned; however, they are compressed into one line in the popup menu.

- ➢ Press the associated softkey (if available) or use the cursor keys to select the list. Press *ENTER* or the rotary knob to expand the list (expand in upward or downward direction depending on the space available).
- ➢ To select a line use the rotary knob.
- ➢ Press *ENTER* to confirm your selection and close the list.
- ➢ Press *ESCAPE* or another key to discard your selection and close the list.



Default Settings	☑
▾Frequency Hopping	
Hopping	On
Hopping Frequency	2700.0000000MHz
Hopping Mode	Absolute
Ramping	On

(Expanding) menu tables

usually cover the whole popup menu or tab so they are active as soon as the menu is opened. The right-hand fields of a menu table (white background) can be edited. Table lines without any input option but with a black triangle are headers with several sub-items that can be expanded or compressed:

- ➢ To move the control frame to a line use the rotary knob or the cursor up/down keys.
- ➢ Press *ENTER* to select a line and start editing. Numerical values can be entered as described in section *Input of Numbers* on page 3.10. Alternative settings can be selected using the rotary knob.
- ➢ Press *ENTER* to confirm an entry and quit the table line.
- ➢ Press *ESCAPE* or another key to discard your entry and release the table line.
- ➢ Select a header line and press the rotary knob to expand (show) or compress (hide) a table section. Press the *ON/OFF* key to expand all compressed tables in the menu.

Measurement Control

This section gives a brief survey of the CMU's measurement control using the function group *RF Non Signalling* as an example. This includes a discussion of the different measurement modes and measured quantities. Settings and measurement parameters frequently encountered are explained from a general point of view.

The formal aspects of measurement control are discussed in more detail in Chapter 5 *(Remote Control – Basics)*.

The menus of the graphical user interface can be arranged in different ways. According to their tasks, they form the following groups:

- The function groups *RF*, *Audio*, *GSM900-MS*, *GSM1800-MS* and *GSM1900-MS*, etc. The *RF* function group is supplied with the firmware for the CMU base system. The function groups for network test applications are optional and described in separate operating manuals.
- The two signalling modes *Signalling* and *Non Signalling*. The signalling properties are specific to the individual networks and devices under test. In the function group *RF* only *Non Signalling* measurements are provided.
- General configurations *(Group Configuration, Connection Control)*, configurations specific to a measured quantity *(Power Configuration, Spectrum Configuration*, etc.), and menus displaying the results of the measurement *(Power, Spectrum* etc.).

In a more formal sense, the CMU uses measurement menus, popup menus, table menus, and graphical measurement menus and dialog windows of various sizes. This aspect is discussed in the preceding sections.

Configurations

The CMU offers a wide range of settings for input and output signals and measurements. Configurations either refer to the whole function group *(Connection Control)* or to a particular measurement.

Connection Control

In function group *RF*, the *Connect. Control* softkey is located on the right side of the title bar of each measurement and graphical measurement menu. It opens a popup menu with several tabs configuring

- The analyzer settings and input path configuration *(Analyzer)*.
- The RF generator *(RF Generator)*
- The RF and possibly the AF connectors to be used and the external attenuation *(AF/RF ⊶)*.
- The reference signal and system clock *(Sync.)*
- The trigger settings *(Trigger)*

All settings made in the *Connect. Control* menu apply to the whole function group and signalling mode. The *Connection Control* menu also contains the input path and the trigger settings for the current function group and signalling state.

Configuration of measurements

A *Configuration* popup menu offering specific settings is assigned to most measurement groups (see e.g. the *Power and Spectrum* measurements in the RF function group and the *Multitone* measurement in the *Audio* function group). The *Configuration* menu also provides general parameters that can be defined independently in many measurement groups:

- The repetition mode, the stop condition, the statistic count and the display mode for the measurement *(Control)*
- Tolerances for the measured quantities *(Limits, Limit Lines)*

These settings are explained in more detail below (see section *General Settings* on page 3.18 ff.). For a detailed explanation refer to the manuals for network tests listed before tabbed divider no. 1.

Measurement Groups

Measurement results are indicated in two different ways:

- Discrete values and parameters are displayed in output fields, lists and tables. In remote control, these results are referred to as scalars.
- Measurement curves (traces) are displayed in a Cartesian coordinate system, the time, frequency or another continuous parameter forming the x-axis scale. Power results are usually plotted in semi-logarithmic diagrams. Relatively small sets of test points are generally viewed in a bar graph. In remote control, results of this type are referred to as arrays.

While the measurement is running in repetition mode *continuous* (see page 3.18), the indicated results are constantly updated. Each function group and measurement mode comprises a particular selection of measurement groups. The measurement groups belonging to function group *RF (Non Signalling)* and *Audio (with option CMU-B41)* are shown in the following tables.

Table 3-4 Measurements in function group *RF (Non Signalling)*

Menu	**Function**
Analyzer/Generator	Shows the settings for the signals generated and analyzed by the instrument, the generator status, and the state of the RF analysis. Moreover the current analyzer power is indicated.
Power	Shows the trace of the measured RF power in oscillographic representation, i.e. as a function of time. The maximum level and frequency of the input signal is indicated in addition. Single points of the trace may be evaluated using graphical tools (markers, D-Line).
Spectrum	Shows the trace of the measured RF power in spectral representation, i.e. as a function of the frequency. Parameters of the measurement are indicated in addition. Single points of the trace may be evaluated using graphical tools (markers, D-Line).

Table 3-5 Measurements in function group *Audio* (with option CMU-B41)

Menu	Function
Analyzer/Generator	Generates a single-tone sinusoidal audio signal and measures the DC and AC voltage and the Total Harmonic Distortion and Noise of a single-tone audio signal.
Multitone	Generates a composite audio signal consisting of up to 20 individual fixed-frequency tones with configurable frequency and level. An audio signal containing the same tones can be analyzed in a single measurement and displayed in a bar chart. A limit check is provided for all results.

A graphical overview of the menus is given at the end of this chapter.

General Settings

A number of settings can be made in several of the configuration menus assigned to the individual measurement groups. In combination, these settings define the scope of each measurement, i.e. the number of results acquired and the type of results displayed. The following brief overview is intended to avoid confusion of terms.

Application

Applications are different measurements belonging to the same measurement group. They effectively split up a measurement group into various related subgroups which can be configured separately.

They are selected via the *Application* softkey in the measurement menus.

Statistic Count / Statistics Cycle

The statistic count is equal to the integer number of evaluation periods which form one statistics cycle. The definition of an evaluation period changes from one measurement to another:

- The evaluation period for *Spectrum* measurements (function group *RF)* corresponds to the duration of a sweep.
- The evaluation period for *Multitone* measurements (function group *Audio)* corresponds to the time until the system has settled and a valid result is available.
- In all digital radio communication systems (GSM, TDMA, CDMA, ...), the information is transmitted in periodic timeslots of equal length. These slots provide natural evaluation periods for all measurements on digital network tests. See the relevant manuals for more specific information.

Depending on the *repetition mode* (see below), a measurement may extend over one or several statistics cycles. The *statistic count* is set in the *Control* tab of the configuration popup-menus assigned to each measurement group. If this parameter is omitted, a statistics cycle always comprises just one evaluation period.

Repetition Mode

The *repetition mode* defines how many statistics cycles are measured if the measurement is not stopped by a limit failure (see stop condition *On Limit Failure* below). Two modes are available for all measurements:

Single Shot	The measurement is stopped after one statistics cycle
Continuous	The measurement is continued until explicitly terminated by the user; the results are periodically updated

A third repetition mode is available in remote control:

Counting	Repeated single shot measurement with a fixed number of statistics cycles

The *repetition mode* is set in the *Control* tab of the measurement configuration popup-menus.

Note: *In contrast to other instrument settings, the repetition modes in manual and remote control are independent and do not overwrite each other. The default repetition mode in manual control is* Continuous *(observe results over an extended period of time), the default mode in remote control is* Single Shot *(perform one measurement and retrieve results).*

Stop Condition

For measurements providing a limit check, two stop conditions can be selected:

None	The measurement is performed according to its repetition mode, regardless of the measurement results,
On Limit Failure	The measurement is stopped as soon as one of the limits is exceeded, regardless of the repetition mode set. If no limit failure occurs, it is performed according to its repetition mode.

Some other stop conditions are defined for network tests. See the relevant manuals for more information.

The *stop condition* is set in the *Control* tab of the measurement configuration popup-menus.

Display Mode

In graphical measurement diagrams, the *display mode* defines which of the measured and calculated curves (traces) is displayed if the measurement extends over several evaluation periods. In general, traces are evaluated at a set of fixed, equidistant test points (samples). After n evaluation periods, n measurement results per test point have been acquired. After a single shot measurement extending over c periods, c measurement results per test point have been acquired.

Current	The current burst, i.e. the last result for all test points, is displayed.
Minimum	At each test point, the minimum value of all bursts measured is displayed.
Maximum	At each test point, the maximum value of all bursts measured is displayed.
Average	At each test point, a suitably defined average over all bursts measured is displayed; see paragraph on *Calculation of average quantities* below.

Note the difference in the calculation of *Average* on one hand, *Minimum, Maximum* and *Max./Min.* on the other hand, if the measurement extends over more than one statistic count (repetition mode *Continuous,* measurement time longer than one statistic count).

After evaluation of the different traces, the burst power is logarithmized and plotted in a semi-logarithmic diagram.

The *display mode* is set in the *Control* tab of the measurement configuration popup-menus.

Calculation of average quantities

The *Average* traces in the *Spectrum* menus are obtained as follows:

Let c be the number of bursts forming one statistics cycle (one *statistic count)* and assume that n bursts have been measured since the start of the measurement. In calculating the *Average* trace, the following two situations are distinguished:

$n \leq c$ Single shot measurement or continuous measurement during the first statistics cycle: At each test point, *Average* trace no. n is calculated from *Average* trace no. n – 1 and *Current* trace no. n according to the following recurrence:

$$Avg(n) = \frac{n-1}{n} Avg(n-1) + \frac{1}{n} Curr(n) \qquad (n = 1, \ldots, c)$$

The *Average* trace represents the arithmetic mean value over all n bursts measured.

$n > c$ Continuous measurement after the first statistics cycle: At each test point, *Average* trace no. n is calculated from *Average* trace no. n – 1 and *Current* trace no. n according to:

$$Avg(n) = \frac{c-1}{c} Avg(n-1) + \frac{1}{c} Curr(n) \qquad (n > c)$$

Scalar quantities are averaged in analogy to *Average* traces. The formulas hold for n = 1 where the average trace becomes equal to the current trace (statistics off).

Note: *Some network tests (e.g. WCDMA) use a different prescription to calculate the average traces. See the relevant manuals for more information.*

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4 Functions and their Application

This chapter explains in detail all functions of the CMU and their application. The structure of the chapter is based on the menu groups and their function. It is organized like a typical measurement session including the following stages:

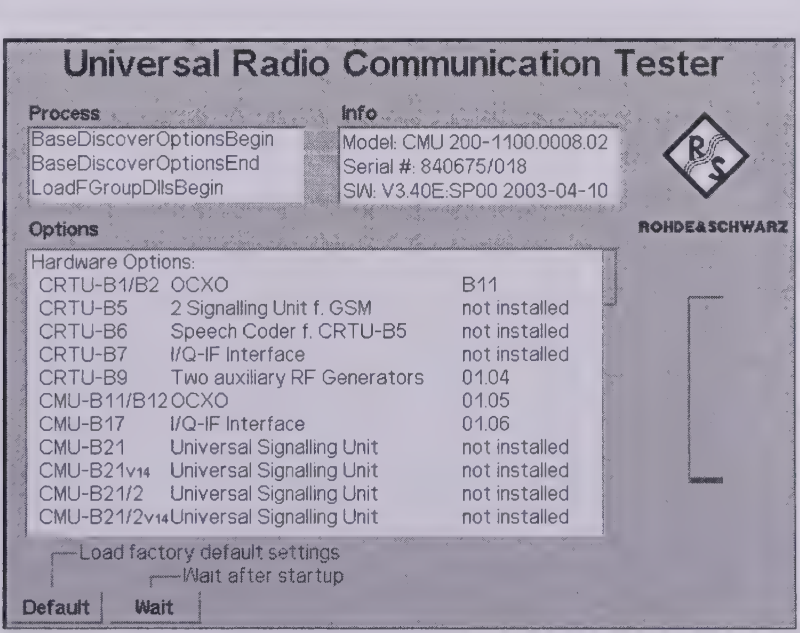
1. Startup menu
2. Menu selection
3. General device configurations
4. System information and hardware diagnosis
5. RF measurements (measurements and measurement results, configurations)
6. *Audio Generator and Analyzer* (Option CMU-B41) including *Audio Multitone*

In contrast to Chapter 6, *Remote Control – Commands*, the measurement and results are explained first, special measurement configurations are relegated to the end of the chapter. The description of the softkeys is followed by the remote-control commands. Similarly, the description of the commands in Chapter 6 also contains the corresponding menus of the user interface.

The description of the operating concept is to be found in Chapter 3; besides, an overview of all menus is given at the end of Chapter 3. To find information on a particular topic please refer to the index at the end of the manual.

Startup Menu

The startup menu provides information on the instrument and the installed options. It appears for a few seconds in the display after switching on the CMU and activating the operating mode (see Chapter 1, *Switching on the Instrument/Startup Test*). During display of this menu, the CMU performs a startup test.


Universal Radio Communication Tester
Process
Info
Options
ROHDE&SCHWARZ
Load factory default settings
Wait after startup
Default
Wait

```
BaseDiscoverOptionsBegin
BaseDiscoverOptionsEnd
LoadFGroupDllsBegin
```

```
Model: CMU 200-1100.0008.02
Serial #: 840675/018
SW: V3.40E:SP00 2003-04-10
```

```
Hardware Options:
 CRTU-B1/B2  OCXO                         B11
 CRTU-B5     2 Signalling Unit f. GSM     not installed
 CRTU-B6     Speech Coder f. CRTU-B5      not installed
 CRTU-B7     I/Q-IF Interface             not installed
 CRTU-B9     Two auxiliary RF Generators  01.04
 CMU-B11/B12 OCXO                         01.05
 CMU-B17     I/Q-IF Interface             01.06
 CMU-B21     Universal Signalling Unit    not installed
 CMU-B21v14  Universal Signalling Unit    not installed
 CMU-B21/2   Universal Signalling Unit    not installed
 CMU-B21/2v14Universal Signalling Unit    not installed
```

Fig. 4-1 Startup menu

Displays in the startup menu

The display windows of the startup menu provide information on

- The startup procedure (*Process)*
- Instrument model, serial number and version of the CMU base software *(Info)*.
- Installed hardware and software options and equipment *(Options)*. Available software options are listed with their version numbers.
- Progress of the startup procedure (*Startup* bar graph).

After terminating the startup procedure, the instrument changes to the last main menu or graphical measurement menu of the previous session.

Options

All the options of the CMU are listed in the section "Installation of Options (Setup – Options)" in this chapter.

Further information on the options is to be found in the data sheet. Installation and removal of options is described in Chapter 4 of the service manual.

Hotkeys

During the startup procedure, the hotkeys of the startup menu are available.

Default

The *Default* hotkey activates the default settings of the instrument for all function groups and test modes. Alternatively, a reset can be performed any time using the *RESET* key; see section *Reset of Instrument Settings (RESET Key)* on p. 4.3 ff.

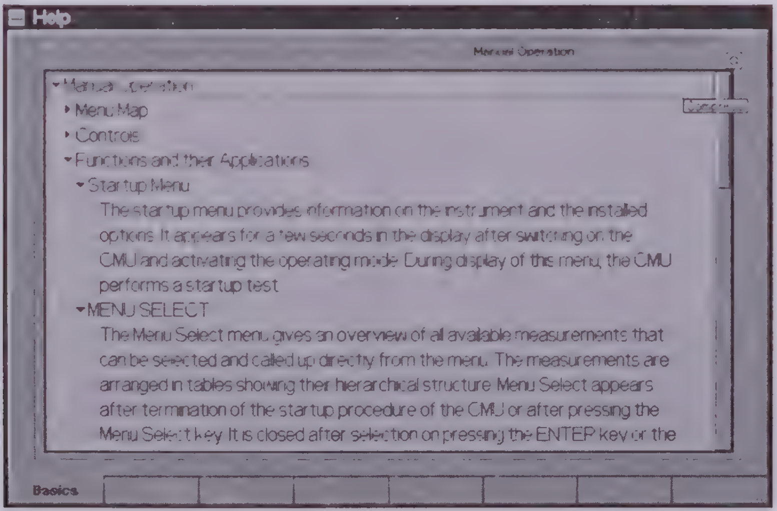
Wait

The *Wait* hotkey prevents the instrument from closing the *Startup* menu.

As a result of this, the *Wait* softkey changes to *Cont.* with the additional message *Change to last menu* displayed on top. Instead of changing to the last main menu or graphical measurement menu of the previous session the measurement can be continued by pressing a key *(Menu Select, Setup, ...)*.

On-Screen Help (HELP Key)

The *Help* menu displays help on the basic menus, controls and keys. It is possible to expand and compress the topics using the *ON/OFF* key. The menu is opened via the *HELP* key *(SYSTEM keypad)*.



- Manual Operation
  - Menu Map
  - Controls
  - Functions and their Applications
    - Startup Menu

      The startup menu provides information on the instrument and the installed options. It appears for a few seconds in the display after switching on the CMU and activating the operating mode. During display of the menu, the CMU performs a startup test.
    - MENU SELECT

      The Menu Select menu gives an overview of all available measurements that can be selected and called up directly from the menu. The measurements are arranged in tables showing their hierarchical structure. Menu Select appears after termination of the startup procedure of the CMU or after pressing the Menu Select key. It is closed after selection on pressing the ENTER key or the

Fig. 4-2 Popup window Help

Reset of Instrument Settings (RESET Key)

The popup window *Reset* sets the instrument settings in all or some function groups and test modes to their default values. It is opened via the *RESET* key *(CONTROL keypad)*.

Note: *A reset of the instrument does not necessarily mean that the current instrument settings are lost. The CMU can store the settings in a configuration file and re-use them in a later session; see section Saving Configurations (Data – Save) on p. 4.22 ff..*

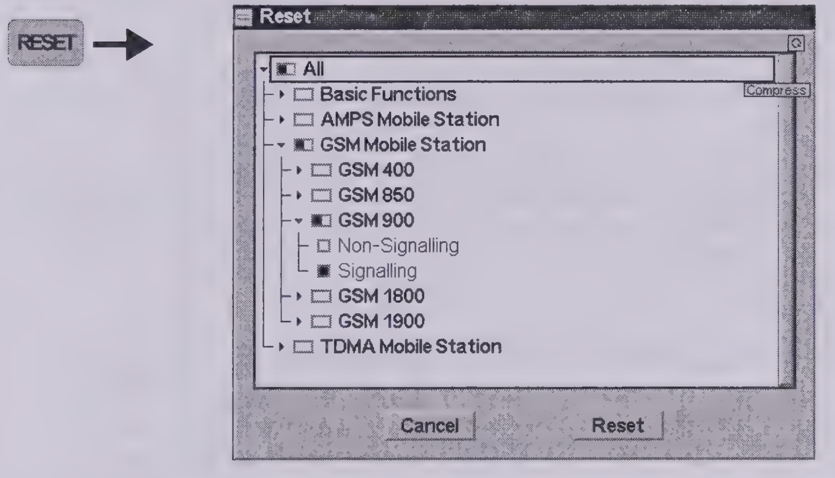


Fig. 4-3 Popup window Reset

Selection of the settings

All function groups and test modes available on the instrument are arranged in a tree view. When the popup is opened, this configuration tree is expanded and the active function group and test mode is selected.

Nodes containing subnodes (e.g. function groups containing the test modes *Non Signalling* and *Signalling)* are marked with rectangular symbols, lowest-level nodes (e.g. the individual test modes within a function group) with smaller, quadratic symbols:

☐	The node is deselected
◧	The node is partially selected, i.e. some but not all of the subnodes are selected
■	The entire node is selected, i.e. all of the subnodes are selected

The controls in the *Reset* window are manipulated with the roll-key, the cursor keys and the *ENTER* key:

⇦ ⇨	Toggle between the *Cancel* and the *Reset* buttons
⇧ ⇩	Toggle between the control buttons *(Cancel, Reset)* and the tree view
Roll-key	Toggles between the *Cancel* and the *Reset* buttons (when turned) or activates a button (when pressed). In the tree view, the roll-key moves the control frame up and down (when turned) or expands/compresses a node (when pressed). Pressing the roll-key on a lowest-level node selects or deselects the node.
ENTER	Activates a button or selects/deselects a node including all subnodes.

Reset

The *Reset* button resets all settings in the selected function groups and test modes.

A box pops up to confirm the reset. While the reset is performed, the message *Reset in progress* is displayed. All running measurements are aborted and a connection to a DUT is dropped. Then the *Reset* popup window is closed and the CMU returns to the function group and test mode that was active when the reset was initiated.

Note: *A reset of the active function group is faster because no additional software modules must be loaded. Additive function groups (e.g. an Audio function group which complements a GSM function group) are reset together with the selected function groups.*

A reset of all instrument settings can also be performed during the startup procedure; see Default *softkey in section Startup Menu on p. 4.1 ff.*

The reset button restores the default values for manual control. In cases where the remote control commands use distinct default values (e.g. the repetition modes) only the manual default values are restored.

Remote control
`SYSTem:PRESet[:ALL]` (base system)
Compare: `SYSTem:RESet[:ALL]` (default parameters in remote control, base system)
`SYSTem:RESet:CURRent` (default parameters in remote control, all function groups)

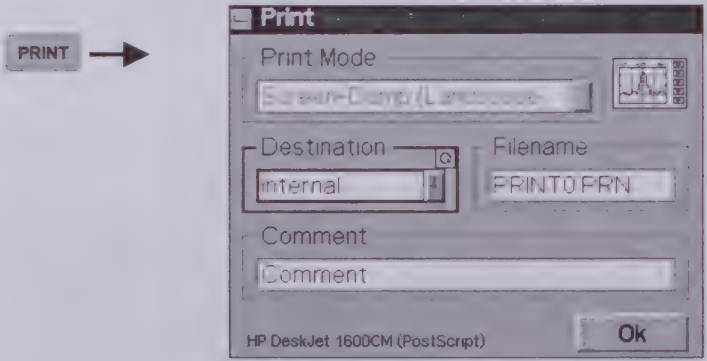
Cancel

The *Cancel* button cancels the selection that has been made and closes the menu. *Cancel* is selected by default when the *Reset* menu is opened.

Remote control
–

Print Menu (PRINT Menu)

The popup window *Print* permits to print the current screen as configured in the *Print* tab of the *Setup* menu. It is called up on pressing the *PRINT* key (*SYSTEM* keypad).



Destination: internal
Filename: PRINT0.PRN
Comment: Comment
HP DeskJet 1600CM (PostScript)

Fig. 4-4 Popup window Print

Print Mode

The *Print Mode* select field permits to specify the data type for the output:

Screen-Dump (Landscape) Copy of the current display in landscape format

An example of a screen-dump copy is shown in a preview to the right of the select field.

Destination

The *Destination* select field permits to specify the output destination for the data:

Printer	Output to external printer connected via the parallel or one of the serial interfaces. The printer is configured in the *Setup – Print* tab; see p. 4.9 ff.
Internal	Storing in the current printer format to directory c:\temp\<Dir> where <Dir> is the target directory specified in the *Filename Default* input field of the *Setup – Print* tab. If <Dir> is not explicitly defined, the files are written to c:\temp.
Internal WMF	Storing in *.wmf format.
External	Storing in the current printer format to the <Dir> target directory (see *Internal* above) on the PCMCIA card (slot 0, right-hand slot) or floppy disk (with option CMU-U61). A message box *Please insert disc ! Repeat ? Yes/No* pops up if no storage medium is inserted in the drive. To print, insert the appropriate medium and confirm with *Yes*.
External WMF	Storing in *.wmf format to the PCMCIA card or floppy disk; see above.

Note: *To make processing of the generated data files easier, we recommend to use the External output destination.*

Filename

If the data is to be written to a file, a file name can be specified in the *Filename* input field. By default, files are stored with the file name defined in the *Setup –print* tab (see p. 4.9). The question mark (?) in this default name is replaced by current numbers starting with zero (auto-increment function). If a file name used before is specified, or if a file where the question mark has been replaced by "9" is already stored in the target directory, a message box *Print: overwrite existing file Yes/No* pops up. Pressing *No* aborts the print procedure and closes the *Print* popup menu.

Comment

The input field *Comment* contains a comment (comprising up to 160 characters) for the current output. This field is not available if a *.wmf output is generated. When the output is sent to a printer the comment is written across the upper edge of the page.

Printer format

The current printer format is indicated below the *Comment* input field. To change this format, open the *Setup –print* tab (see p. 4.9) to select another printer.

Ok

The *Ok* button starts the data output and closes the *Print* menu.

To cancel the print process while preserving the current settings and close the *Print* menu press the *PRINT* key again.

Remote control

–

Menu Select

The *Menu Select* menu gives an overview of all available measurements that can be selected and called up directly from the menu. The measurements are arranged in tables showing their hierarchical structure. *Menu Select* appears after termination of the startup procedure of the CMU or after pressing the *Menu Select* key. It is closed after selection on pressing the *ENTER* key or the *MENU SELECT* key again. The *ESCAPE* key discards the current selection.

MENU SELECT →

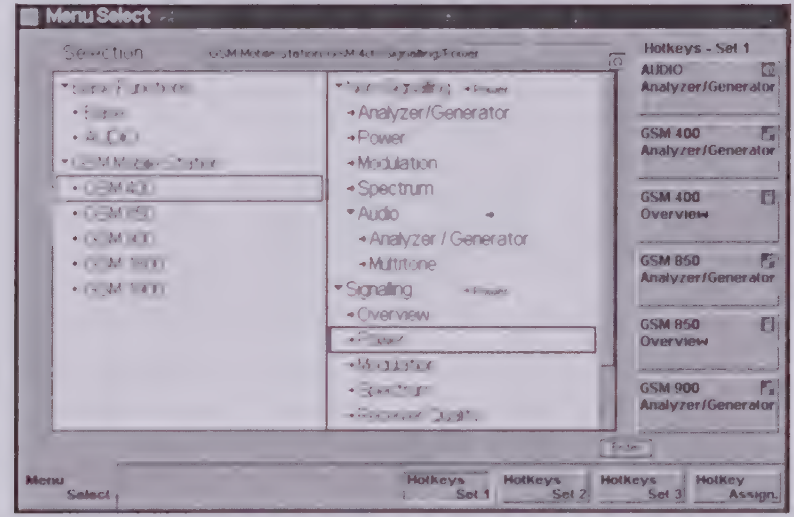

Menu Select
Selection
Analyzer/Generator
Power
Modulation
Spectrum
Audio
Analyzer / Generator
Multitone
Signaling
Overview
Hotkeys - Set 1
AUDIO Analyzer/Generator
GSM 400 Analyzer/Generator
GSM 400 Overview
GSM 850 Analyzer/Generator
GSM 850 Overview
GSM 900 Analyzer/Generator
Menu Select
Hotkeys Set 1
Hotkeys Set 2
Hotkeys Set 3
Hotkey Assign.

Fig. 4-5 Menu Select

Selection table: function groups

The left half of the *Selection* table contains all function groups available on the instrument. The CMU performs general RF measurements accessible via the function group:

RF	RF measurements, see below in this Chapter

If equipped with option CMU-B41, it provides AF measurements via the function group:

Audio	Audio generator and analyzer including multitone measurements, see below in this Chapter

It is a versatile measuring instrument for a large variety of digital and analog network tests (all of them are optional, see separate manuals). For a complete list of deliverable network tests please refer to the data sheet.

Selection table: test modes and menus

When a function group is selected, the measurements within this group are displayed in the right half of the table. A measurement generally consists of measurement menus and specific configuration menus. A complete graphical overview of all menus of the CMU basic system and the function groups *RF* and *Audio* can be found at the end of chapter 3 in this manual.

Most of the optional network test function groups are divided into the two independent test modes:

Non Signalling	Module tests; measurements without transmission of signalling parameters and call setup.
Signalling	Measurements with signalling and call setup to the device under test.

The test modes form the header lines of expandable table sections. A measurement may be available in both test modes of a function group, therefore, to uniquely define a measurement, it is necessary to specify its name, the test mode (if applicable) and the function group.

Example

In *Fig. 4-5*, the *Power* measurement is selected. This measurement belongs to the *Signalling* test mode in function group *GSM400-MS*. Another *Power* measurement belongs to the *Non Signalling* test mode of the same function group.

Hotkey Assign.

The *Hotkey Assign.* hotkey activates the assign mode used to assign a softkey to the function group, signalling mode and measurement menu currently selected.

The six softkeys of the *Menu Select* menu belonging to *Hotkeys Set 1* have a default assignment. In normal mode, each hotkey gives direct access to the menu assigned to it. Another two sets, each containing six softkeys, can be accessed by pressing the *Hotkeys Set 2* or *Hotkeys Set 3* hotkeys, respectively.

In the assign mode, the *Hotkey Assign.* softkey turns into *Exit Assign* softkey and *Hotkey Assignment* is displayed in the header of the *Menu Select* menu.

- ➢ To assign a softkey (or to change the current assignment), select the desired function group, mode and menu, and press *Hotkey Assign.* followed by the softkey. Press *Exit Assign.* to quit the assign mode.
- ➢ To cancel a hotkey assignment, press *Hotkey Assign.* followed by the *DEL* (delete) key and the softkey. Press *Exit Assign.* to quit the assign mode.

Note 1: *An empty configuration (all hotkeys de-assigned) will not be not stored after* Exit Assign. *Instead the CMU restores the default hotkey assignment of the current function group.*

Note 2: *A user-defined assignment is retained even after a Reset of all function groups* (Reset *key, see p.* 4.3 *f).*

Remote control

The CMU uses extended addressing: The instrument itself is identified by the primary GPIB address. Moreover, a secondary address must be assigned to any combination of a function group and a signalling mode. This is done with the command

```
SYSTem:REMote:ADDRess:SECondary <Address>,<FGrp>|NONE
```

Primary and secondary address handling is described in the remote control Chapters (in particular, refer to chapter 5 and the program examples in chapter 7).

Hotkeys Set 1

The *Hotkeys Set 1* hotkey selects the softkey set 1 for display. The hotkey is active in normal mode and in assign mode; see description of previous hotkey.

The two hotkeys *Hotkeys Set 2* and *Hotkeys Set 3* are analogous to *Hotkeys Set 1*.

Audio Multitone

The labeling of each softkey on the right side of the menu contains the function group, an icon indicating the test mode, and the measurement assigned to the softkey. The function of the softkeys is as follows:

- In normal mode, pressing a softkey calls up the corresponding measurement.
- In assign mode, pressing a softkey assigns this softkey to the measurement selected in the *Selection* table. Pressing the *DEL* (delete) key and then the softkey cancels the current assignment.

Popup Menu Setup

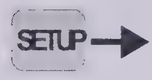
The popup menu *Setup* contains several tabs used to adapt the CMU to user requirements. The menus are opened by pressing the *Setup* key. It is possible to change between the tabs by pressing the associated hotkeys.

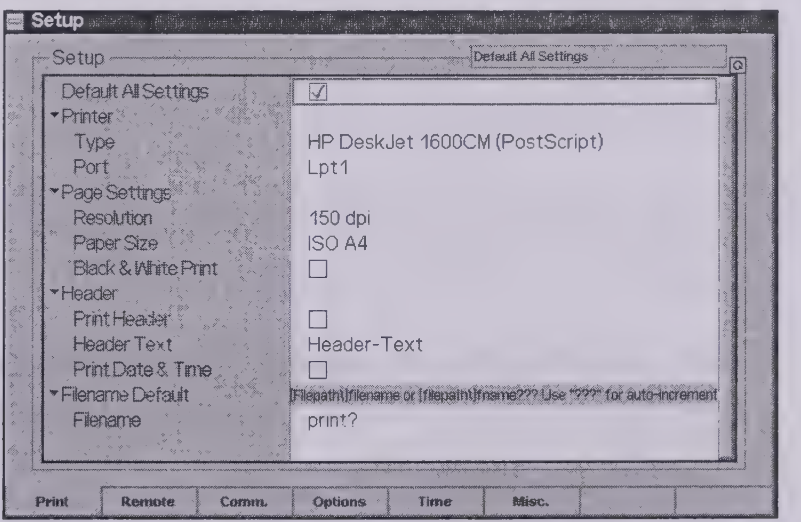
Printer Settings (Setup – Print)

The *Setup – Print* menu controls the output of data from the CMU to a printer or a storage medium. The following configurations are provided:

- Printer type and port selection *(Printer)*
- Page settings for the selected printer *(Page Settings)*
- A header for the printed page *(Header)*
- Default file name and directory *(Filename Default)*

Some of the *Setup – Print* configurations serve as default settings and can be modified in the *Print* popup menu before the print process is started (see p. 4.4).





Default All Settings	☑
▾Printer	
Type	HP DeskJet 1600CM (PostScript)
Port	Lpt1
▾Page Settings	
Resolution	150 dpi
Paper Size	ISO A4
Black & White Print	☐
▾Header	
Print Header	☐
Header Text	Header-Text
Print Date & Time	☐
▾Filename Default	[Filepath\]filename or [filepaht\]fname??? Use "???" for auto-increment
Filename	print?

Fig. 4-6 Printer configuration menu (Setup – Print)

Default Settings The *Default All Settings* switch assigns default values to all settings in the *Print* tab (the default values are quoted in the command description in chapter 6 of this manual).

Printer The *Printer* table section selects a printer type and the printer port. The connection of a printer is described in chapter 1.

Page Settings The *Page Settings* section activates the input of the page settings for the selected printer.

Resolution	Fixed 150 dpi printer resolution
Paper Size	Selection of ISO A4 or US LETTER paper
Black & White print	Color (check box off) or black & white printer

Header	The *Header* section defines and activates header for the printed page.
	Print header — Print the header defined in the *Header Text* input field when a page is printed. An additional comment for every single page can be defined in the *Print* popup menu (see p. 4.4).
	Header Text — Input field for a header with a maximum length of two lines.
	Print Date & Time — Inclusion of the current date and time in the header, provided that a header is to be printed.

Filename Default The *Filename Default* section defines a default file name and directory for an output that is written to an internal or external storage medium.

It is possible to specify a path separated from the filename by a backslash "\" in order to create a directory structure on the storage medium. This path is relative to directory c:\temp of the CMU hard disk *(Internal* storage) or the root directory of the *External* storage medium.

Auto-increment function A question mark within the file name is replaced by current numbers that are automatically incremented, starting with zero. The file name *PRINT?* means that the first file stored will be *PRINT0*, the next one will be *PRINT1* etc. To create more than 10 different print files, another name or destination must be specified.

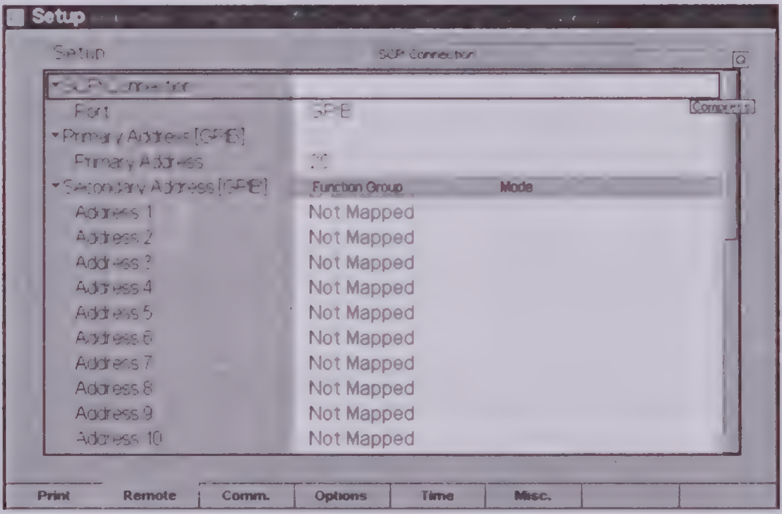
Remote control

Remote-control Settings (Setup – Remote)

The remote-control menu *(Setup Remote)* defines the remote-control parameters of the CMU:

- Selection of the interface *(SCPI-Connection)*,Setting of the IEC-bus address of the CMU *(Primary Address)*,
- Selection of the desired function group *(Second. Address)*.

SETUP →



▾ SCPI Connection		
Port	GPIB	
▾ Primary Address [GPIB]		
Primary Address	20	
▾ Secondary Address [GPIB]	Function Group	Mode
Address 1	Not Mapped	
Address 2	Not Mapped	
Address 3	Not Mapped	
Address 4	Not Mapped	
Address 5	Not Mapped	
Address 6	Not Mapped	
Address 7	Not Mapped	
Address 8	Not Mapped	
Address 9	Not Mapped	
Address 10	Not Mapped	

Fig. 4-7 IEC-bus menu

SCPI Connect

The *SCPI Connection* section determines the remote-control interface of the CMU.

The following interfaces are available:

GPIB	IEEE-bus interface according to IEEE 488
COM 1	Serial (RS-232-C) interface COM 1
COM 2	Serial (RS-232-C) interface COM 2

For the characteristics of the interfaces see Chapter 1 and Chapter 8, "Hardware Interfaces ".

Primary Address [GPIB]

The *Primary Address* section sets the IEC-bus address of the CMU. The default setting is 20; addresses 0 to 30 can be assigned.

The IEEE-bus address is addressed in the remote-control commands in the form of the associated primary address, see Chapter 5, *Switchover to Remote Control*, and Chapter 7, *Program Examples*.

Remote control

```
SYSTem:COMMunicate:GPIB[:SELF]:ADDRess  0 to 30
SYSTem:REMote:ADDRess:PRIMary  0 to 30
```

Second. Address [GPIB]

The *Second. Address* section assigns secondary addresses to up to 29 function group and test mode combinations (secondary address 0 is always mapped to the base system; no re-mapping is possible). The available function groups (e.g. *RF Non Signalling*, *GSM 900 Signalling* etc.) can be displayed and selected with the roll-key after an *Address n* field is activated.

The network and the test (signalling) mode are addressed in the remote-control commands in the form of the associated *secondary address*, see Chapter 5, *Setting the Device Addresses,* and Chapter 7, *Program Examples*.

Remote control

```
SYSTem:REMote:ADDRess:SECondary  1 to 29,<FgrpName> | NONE
```

Local ➠ Remote Transition

Defines the behavior of the CMU in a local to remote transition. The command is valid for all function groups and test modes, however, its effect depends on the test mode *(Signalling* or *Non Signalling* tests, see e.g. *GSMxxx-MS* manual):

Disconnection on (box checked)	In *Signalling* mode, the connection or call is dropped and the CMU returns to its default signalling state (e.g. *SOFF* in the *GSMxxx-MS* function groups). In *Non Signalling* mode, all generators are switched off.
Disconnection off	In *Signalling* mode, all signalling states are maintained. This makes it possible to switch the instrument to remote control without dropping a call or connection. In *Non Signalling* mode, the current operating state of all generators is maintained.

Remote control

```
SYSTem:GTRMode:COMPatible ON | OFF
```

Serial Interfaces (Setup – Comm.)

The interface menu *(Setup Comm.)* defines the transmission parameters of the serial outputs COM 1 and COM 2.

SETUP →

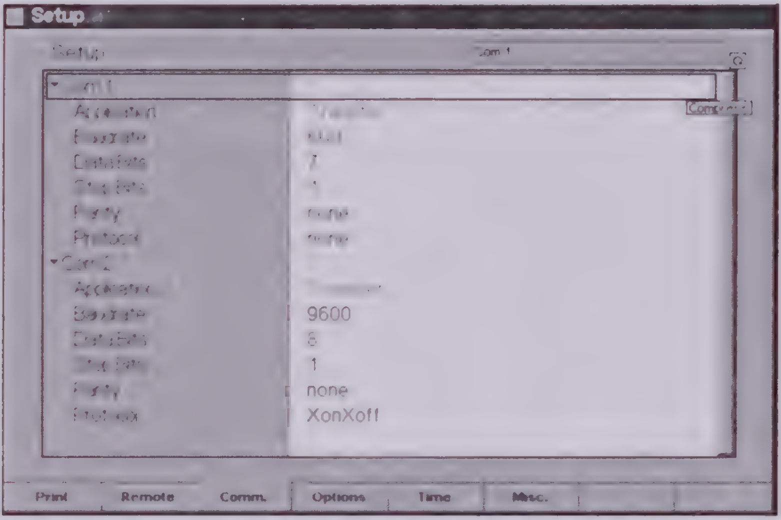


Fig. 4-8 Interface menu

COM 1

The COM 1 section defines the transmission parameters for the serial interface COM 1.

If required, the transmission parameters must be set such as to comply with the parameters of the addressed device (PC etc.). The interface characteristics are explained in detail in Chapter 8, *Hardware Interfaces*. The individual parameters are presented in *Table 4-1* below.

The *Application* field indicates whether the serial port is used as a printer connector *(Printer*, if COM 1 was selected as printer port in the *Print* tab; see p. 4.9) or for data transfer to the controller *(Transfer*, default setting). This parameter can not be changed in the *Comm.* tab.

Remote control

```
SYSTem:COMMunicate:SERial1:APPLication
SYSTem:COMMunicate:SERial1:TRANsmit:PACE... etc.
```

Table 4-1 Transmission parameters of the serial interfaces

Parameter	Meaning	Value range
Application	Addressed device	Transfer | Printer (fixed setting)
Baud Rate	Data transmission rate	110 |300 | 600 | 1200 | 2400 | 4800 | 9600 | 19200 | 38400 | 57600 | 115200
Data Bits	Number of data bits	7 | 8
Stop Bits	Number of stop bits	1 | 2
Parity	Number of parity bits	none | odd | even
Protocol	Transmission protocol	none | XonXoff | CtsRts

COM 2

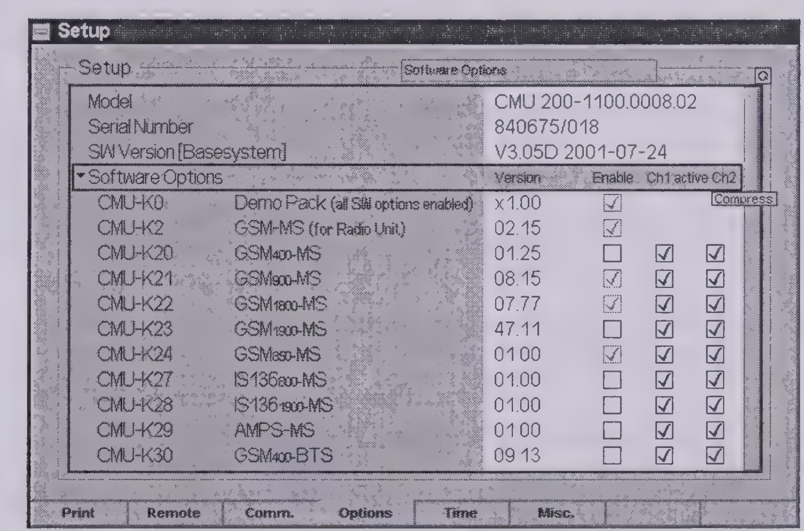
The COM 2 section defines the transmission parameters for the serial interface COM 2. The parameters are analogous to the COM 1 parameters.

Remote control
`SYSTem:COMMunicate:SERial2:APPLication`
`SYSTem:COMMunicate:SERial2:TRANsmit:PACE... etc.`

Enabling Options (Setup – Options)

The option menu *(Setup Options)* provides information on the type of instrument and the installed options, equipment and firmware versions *(Software Options, Hardware Options, Hardware Equipment, Firmware Versions)*. New software options purchased can be enabled in this menu using a code number.

SETUP →



Model CMU 200-1100.0008.02
Serial Number 840675/018
SW Version [Basesystem] V3.05D 2001-07-24

Software Options		Version	Enable	Ch1 active	Ch2
CMU-K0	Demo Pack (all SW options enabled)	x 1.00	☑		
CMU-K2	GSM-MS (for Radio Unit)	02.15	☑		
CMU-K20	GSM$_{400}$-MS	01.25	☐	☑	☑
CMU-K21	GSM$_{900}$-MS	08.15	☑	☑	☑
CMU-K22	GSM$_{1800}$-MS	07.77	☑	☑	☑
CMU-K23	GSM$_{1900}$-MS	47.11	☐	☑	☑
CMU-K24	GSM$_{850}$-MS	01 00	☑	☑	☑
CMU-K27	IS136$_{800}$-MS	01.00	☐	☑	☑
CMU-K28	IS136$_{1900}$-MS	01.00	☐	☑	☑
CMU-K29	AMPS-MS	01 00	☐	☑	☑
CMU-K30	GSM$_{400}$-BTS	09 13	☐	☑	☑

Fig. 4-9 Options menu

Info section: The three lines above the *Software Options* section contain the following information on the instrument.

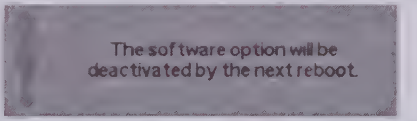
Model	Instrument model
Serial No.	Serial number of the instrument
SW Version [Basesystem]	Installed base system firmware with date of release

Remote control
`SYSTem:OPTions:INFO?`
addition information about the installed firmware options can be queried via `SYSTem:OPTions:INFO:CURRent?` in all function groups and test modes.

Software Options

The *Software Options* section contains a list of all software options for the CMU. The check boxes behind each software option determine the system configuration:

Enable	Enable (box checked) or disable software option. Options purchased with a new unit are already enabled. Software options purchased later must be explicitly enabled with a key code to be functional; see below.
Ch1 active Ch2	Activate (box checked) or deactivate software option on the next reboot. After deactivating an option by unchecking one of the boxes, the CMU displays the following message:



The software option will be deactivated by the next reboot.

Deactivating software options that are temporarily not needed improves the system performance, especially during the start-up process when all active firmware options must be loaded. An enabled but deactivated option can be re-activated any time without any key code or other additional input.

Note: *Some options, e.g. options CMU-K39 to CMU-K43, are supplementary options extending the GSM-BTS and GSM-MS options. The supplementary options must be enabled with a key code but can not be deactivated. No* Ch1 active Ch2 *boxes are provided.*

Enabled options are active by default. Disabled options are inactive and can not be activated.

Remote control
`SYSTem:OPTions?`
`*OPT?`

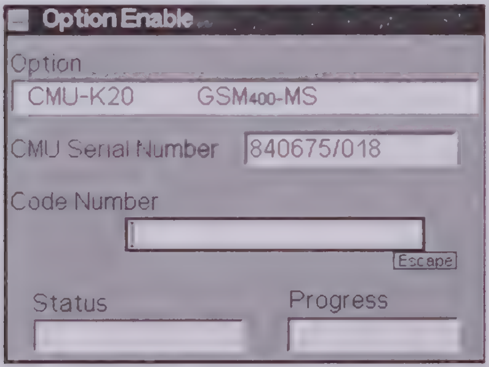
Enabling software options

Software options can be enabled or disabled in the *Enable* check boxes of the *Software Options* table. As all software options are already included in the firmware, enabling does not require any re-installation, but only a key code which is supplied with the option.

➢ Select the respective line in the list of software options (in the example of *Fig. 4-9* the line *CMU-K20 GSM400-MS)*,

➢ Press the *Enter* key.

The popup window *Option Enable* appears on the screen:



Option: CMU-K20 GSM400-MS

CMU Serial Number: 840675/018

Code Number:

The *Option Enable* window contains the following fields:

Option	Short designation and name of option
CMU Serial Number	Serial number of the CMU basic instrument

Code Number	Code number of the option to be installed
Status	Indication of the next operating step to perform
Progress	Progress of the enabling procedure

Of the five fields, only the *Code Number* can be edited. The name of the option being enabled and the serial number of the CMU are automatically entered into the corresponding fields.

➢ Enter the code number of the option in the input field *Code Number*.

➢ Confirm the entry using *Enter*.

The option is automatically enabled.

Remote control
–

Hardware Options / Hardware Equipment / Firmware Versions

The *Hardware Options* section lists all hardware options for the current CMU model (CMU200 or CMU300). Additional hardware accessories are listed in the *Hardware Equipment* section. The table shows the product index or *not installed*, if the CMU is not equipped with the hardware option or equipment.

Note: *An comprehensive list of the hardware equipment of the instrument is provided in the Info menu; see p. 4.18.*

The FW version for RXTX Board 1 (uP1) and RXTX Board 2 (uP2) is displayed in the *Firmware Versions* section. This information is mainly intended for service purposes.

Further information on the options can be found in the data sheet. Installation and removal of hardware options is described in Chapter 4 of the CMU service manual.

Note on Front Module controller

The version of the Front Module controller has an impact on the shut down process of the instrument; see Chapter 1, section Switching off the Instrument. *When operating instruments equipped with an FMR 6 in remote control mode, it is recommended to disable the nonvolatile RAM, see command* `SYSTem:NONVolatile:DIsable` *in Chapter 6.*

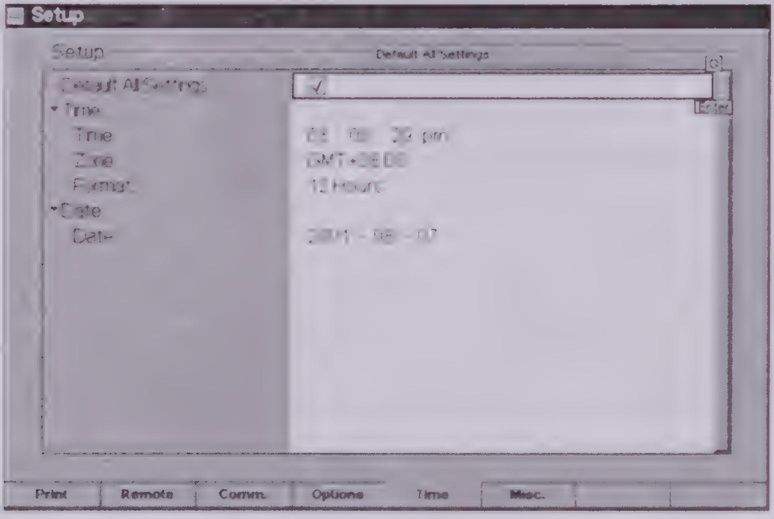
Remote control
`SYSTem:OPTions?`
`*OPT?`

Time Settings (Setup – Time)

The *Setup Time* tab shows and permits to change the following settings:

- The (current) time zone, time and time convention *(Time)*
- The (current) date *(Date)*

SETUP →



Default All Settings ✓

Time
Time
Zone
Format 12 Hours
Date
Date

Fig. 4-10 Time menu

Default Settings	The *Default All Settings* switch assigns default values to all settings in the *Time* tab (the default values are quoted in the command description in chapter 6 of this manual). Remote Control

Time The *Time* table section sets the current time and its display format:

hh:mm:ss.	Time in the format hours:minutes:seconds	
Zone	Selection of the time zone, Middle European time (Greenwich mean time (GMT) + 1 h) is set by default	
Format	12 Hours:	12:00:00 am ... 11:59:59 am 12:00:00 pm ... 11:59:59 pm
	24 Hours	0:00:00 ... 23:59:59

Remote control
`SYSTem:TIME:TIME`
`SYSTem:TIME:TZONe`

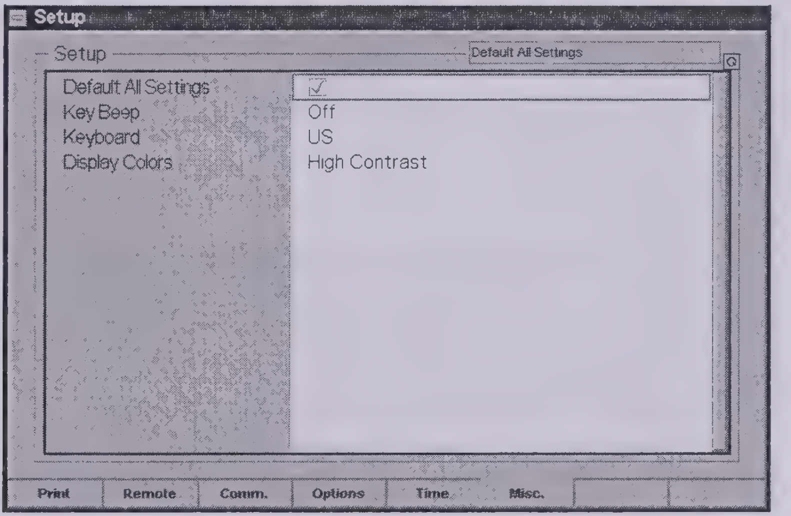
Date The *Date* section defines the current date in the format yyyy-mm-dd (year-month-day).

Remote control
`SYSTem:DATe`

Acoustic Signal and Keyboard (Setup – Misc.)

The *Setup Misc.* menu activates the acoustic signal *(key beep)* and selects the keyboard assignment *(Keyboard)*.

SETUP →



Default All Settings	✓
Key Beep	Off
Keyboard	US
Display Colors	High Contrast

Fig. 4-11 Setup – Misc. menu

Key Beep *Key Beep* switches the acoustic signal of the CMU on or off. If the key beep is *On* the CMU sends a discreet acoustic signal whenever a key is pressed. The default setting is *Off*.

Remote control
`SYSTem:MISC:KBEep`

Keyboard *Keyboard* selects the keyboard assignment *(German* or *US* keyboard).

Remote control
`SYSTem:MISC:KEYBoard`

Display Colors *Display Colors* selects the brightness of the CMU's LC display. In the *High Contrast* setting, the display is darker; the contrasts are enhanced.

Remote control
No command, screen configuration only.

System Information (Info)

The *Info* popup menu, which is opened by pressing the *INFO* key, displays comprehensive information on the instrument and its components and provides a number of selftests.

Hardware Equipment

The *Hardware Equipment* tab of the *Info* menu lists all hardware equipment of the instrument. Part of the information is also displayed in the *Options* tab of the *Setup* menu; see p. 4.13 ff.

INFO →

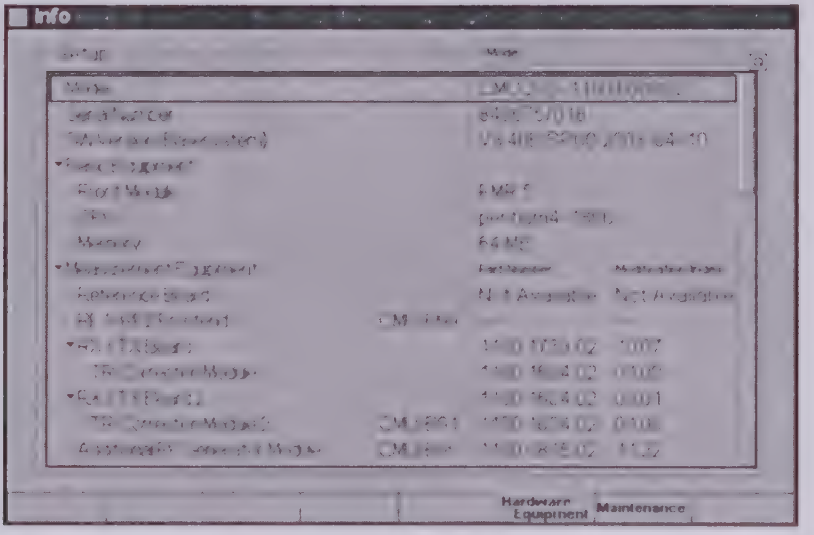
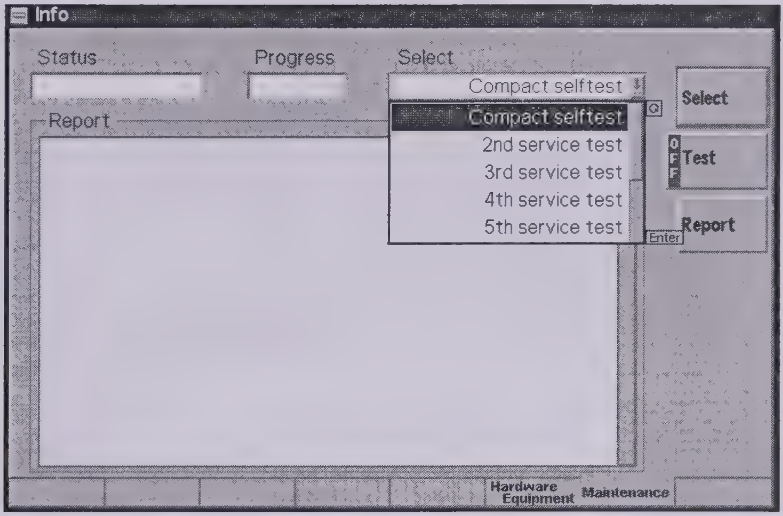


Fig. 4-12 Info – Hardware Equipment

Selftest (Info – Maintenance)

The *Maintenance* tab of the *Info* menu provides a number of selftests, primarily intended for service purposes.


Info
Status
Progress
Report
Compact selftest
2nd service test
3rd service test
4th service test
5th service test
Enter
Select
OFF
Test
Report
Hardware Equipment
Maintenance

Select: Compact selftest

Fig. 4-13 Info – Maintenance menu

Select

The Select softkey selects the type of selftest to be carried out. If a test is selected and the *Test* softkey is pressed (see below), the selftest is started and the results are displayed in the *Report* window.

The tests are to retrieve diagnosis voltages and configuration info about different hardware modules, primarily for service purposes. The information is obtained as explained for *System Info.*

Remote control
–

Test

The *Test* softkey initiates the selftest selected via the *Select* softkey and displays it in the Report table.

The status of the selftest *(RUN, OFF, HLT;* the *RUN* state usually last only for a very short time) is indicated – like any other measurement status – on the left side of the softkey. It can be changed after softkey selection (press once) by means of the *ON/OFF* key.

A short description of the current test appears in the *Status* output field; its progress is shown in the *Progress* bar.

Remote control
–

Report

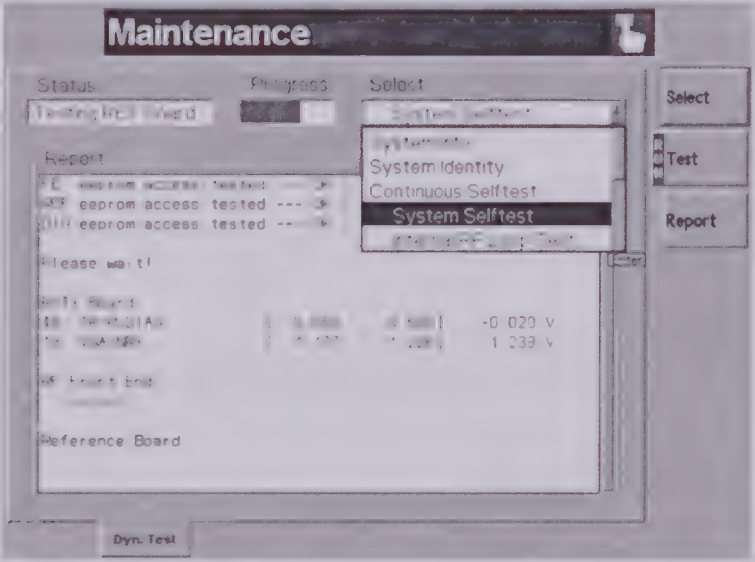
The *Report* softkey activates the *Report* table, e.g. for scrolling.

Remote control
–

Selftest (Maintenance)

The *Maintenance* popup menu, which is accessible via the *BASE* function group in the *Menu Select* menu, complements the *Info* menu (see p. 4.18 above) in providing service information, selftests and correction procedures that are aimed to improve particular measurements. The selftests are primarily intended for production and service purposes and therefore not needed during normal operation of the instrument. The following description serves as a general overview.

Menu Select



```
eeprom access tested ---
eeprom access tested --

Please wait!

                                   -0.020 V
                                    1.239 V

Reference Board
```

Fig. 4-14 Selftest – Maintenance menu

Select

The *Select* softkey selects the type of selftest or correction procedure to be performed.

Note: *The Select drop-down list always contains all entries listed below. If the selftest is started for a board that is not available in the unit, a message "<Board_Name> board is not available" is displayed.*

System Info	Provides information on the system memory and the hardware and software configuration. If *System Info* is selected and the *Test* activated (see below), the CMU lists all deliverable hardware and software options in the report table and indicates whether they are available on your CMU.
System Identity	Scans all modules and stores the part numbers and production data to file c:\identity.dat. In addition the available software versions are written to the log file C:\INTERNAL\LOG\VERSION.LOG.

Continuous Selftest	Continuous combined *System Selftest* and *Internal RF Loop* selftest. The continuous selftest is repeated until it is explicitly switched off.
System Selftest	Tests all modules one after another and displays a pass/fail message.
Internal RF Loop Test	Test of frequencies and levels at connectors RF1 and RF2 using the CMU's internal RF generator and analyzer with internal RF coupling.
1->4/3->2 RF Loop T.	Test of frequencies and levels for the RF path between the connectors RF1 –> RF4 IN and RF3 OUT –> RF2. For this test, special external N coax cables (included in service kit CMU-Z3) must be used to close the RF path.

The remaining tests are selftests for individual modules, e.g. Front End, Reference Board, Digital Board, RXTX Board 1, Audio Board, I/Q-IF Board (Option CMU-B17), Aux Tx Board (Option CMU-B95). Besides, the following correction procedures are available:

Audio Board Calib.	Improves the accuracy of Audio measurements (with option CMU-B41; see section *Audio Generator and Analyzer).*
FM Modulation Calib.	Improves the accuracy of measurements on FM-modulated signals (e.g. for *Bluetooth* (CMU-K53), AMPS (CMU-K29)).
Correction Filter Cal.	Improves the accuracy of WCDMA modulation measurements (only with options CMU-K65/.../-K69 (CMU200) or CMU-K75/-K76 (CMU300) and CMU-Z6, see operating instructions for CMU-Z6, stock no. 1150.0199.12).
L1CoPro TX Calib.	Improves the level accuracy of the downlink WCDMA generator (option CMU-K66).
Internal Aux Tx Loop Test	Same as *Internal RF Loop Test,* but for the Aux Tx signal (option CMU-B99).

Remote control

–

Test

The *Test* softkey controls the selftest of the type selected via the *Select* softkey and displays the results in the *Report* table.

The status of the selftest *(RUN, OFF, HLT)* is indicated on the left side of the softkey. It can be changed after softkey selection (press once) by means of the *ON/OFF* key.

A short description of the current test appears in the *Status* output field; its progress is shown in the *Progress* bar.

Remote control

–

Report

The *Report* softkey activates the *Report* table, e.g. for scrolling.

Remote control

–

Data Handling (Data)

The *Data* popup menu, which is opened by pressing the *DATA* key, saves and recalls configuration files, handles log files for GSM layer 3 messages and manages the files in the internal and external memories that can be used for mass storage.

Saving Configurations (Data – Save)

The *Save* tab in the *Data* popup menu stores the current instrument settings to a configuration file. Configuration files have the extension *.SAV and contain the following information:

- All user-defined settings of a particular function group and test mode comprising all measurement settings (defined in the measurement configuration menus) and all general settings (defined in the *Connection Control* menu)
- For *Signalling* test mode, all settings concerning signalling (connection setup etc.)
- For the *Base* system, the current function group, test mode and measurement menu.

The configuration of several function groups and test modes can be written to a common configuration file. The configuration of the current session is automatically stored in the non volatile RAM before a session is terminated and re-activated when the CMU is started next time; see also Chapter 1, section *CMU VersionManager.*

DATA →

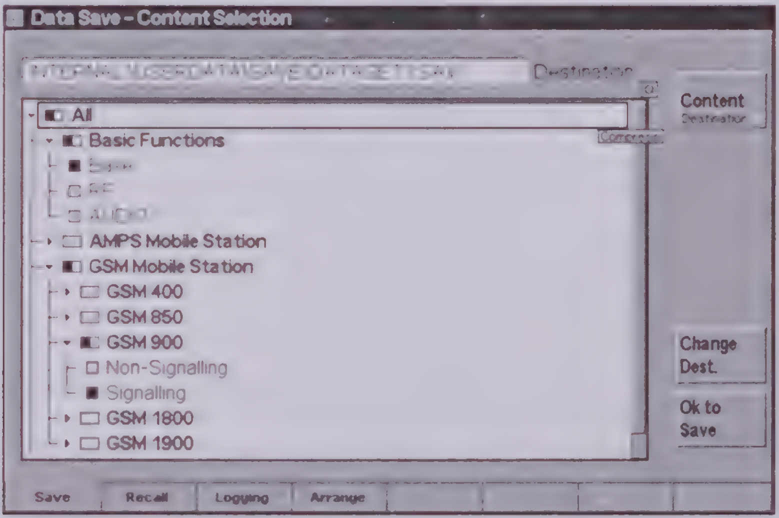

Data Save - Content Selection
Destination
All
Basic Functions
AMPS Mobile Station
GSM Mobile Station
GSM 400
GSM 850
GSM 900
Non-Signalling
Signalling
GSM 1800
GSM 1900
Content
Destination
Change Dest.
Ok to Save
Save
Recall
Logging
Arrange

Fig. 4-15 Data – Save menu

Selection of function groups

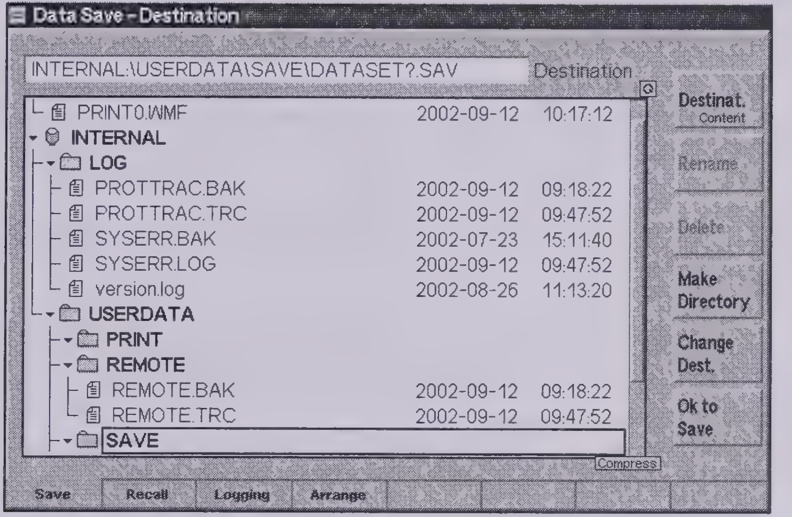
All function groups and test modes available on the instrument are arranged in a tree view showing the function groups and test modes to be saved to a configuration file. When the popup is opened, the configuration tree is expanded and the active function group and test mode is selected. The tree view is identical to the tree in the *Reset* menu (see section *Reset of Instrument Settings (RESET Key)* on p. 4.3 ff.).

The *Base* system is part of every software configuration and therefore selected by default irrespective of the current function group and mode. It is possible though to exclude the base system settings from the configuration file by deselecting the *Base* node.

Note: *If the base system is excluded from the configuration, the current function group, test mode and measurement menu are not stored to* *the configuration file. In this case it can be useful to write this information to the file comment; see Change Dest. softkey below.*

Content Destination

Content/Destination toggles between the configuration tree (see *Fig. 4-15 above*) and a view of the directories available for storing the configuration file (*.SAV). The *Destination* view is analogous to the *Arrange* tab; see section *File Manager (Data – Arrange)* on p. 4.29 ff.


Data Save - Destination

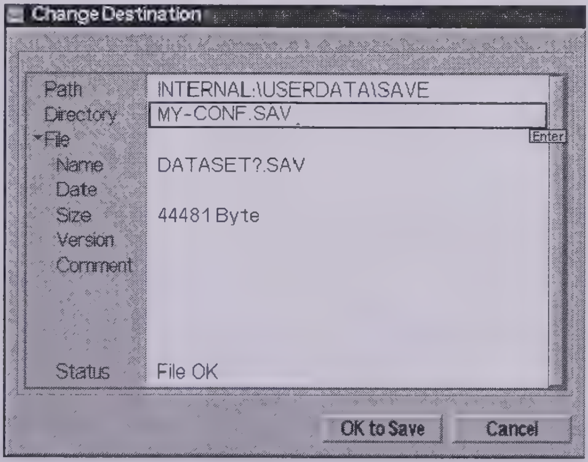
INTERNAL:\USERDATA\SAVE\DATASET?.SAV Destination

```
└ PRINT0.WMF                2002-09-12   10:17:12
▾ INTERNAL
├▾ LOG
│ ├ PROTTRAC.BAK            2002-09-12   09:18:22
│ ├ PROTTRAC.TRC            2002-09-12   09:47:52
│ ├ SYSERR.BAK              2002-07-23   15:11:40
│ ├ SYSERR.LOG              2002-09-12   09:47:52
│ └ version.log             2002-08-26   11:13:20
└▾ USERDATA
  ├▾ PRINT
  ├▾ REMOTE
  │ ├ REMOTE.BAK            2002-09-12   09:18:22
  │ └ REMOTE.TRC            2002-09-12   09:47:52
  ├▾ SAVE
```
Destinat. Content
Rename
Delete
Make Directory
Change Dest.
Ok to Save
Compress
Save
Recall
Logging
Arrange

Remote control
–

Change Dest.

The *Change Dest.* softkey opens a dialog to specify the name and path of the created configuration file and enter a *Comment* to be stored with the file. See also *View Info/Rename* softkey on p. 4.30.


Change Destination

Path INTERNAL:\USERDATA\SAVE
Directory MY-CONF.SAV
▾File
Name DATASET?.SAV
Date
Size 44481 Byte
Version
Comment
Status File OK

Enter
OK to Save
Cancel

Editing the *Change Destination* dialog is optional: By default, the CMU stores configuration files to the directory *INTERNAL\USERDATA\SAVE* and uses the file names DATASET?.SAV where the question mark is replaced by current numbers that are automatically incremented, starting with zero (auto-increment function). To create more than 10 different configuration files, another name or destination must be specified. The information stored in a configuration file can not be edited.

Selecting *OK to Save* closes the dialog window and stores the inputs made. Pressing *Cancel* or *Change Dest.* again without selecting *OK to Rename* closes the dialog box, discarding all inputs made.

Remote control
The path, directory, file name and comment of an existing configuration file can be changed using the `MMEMory` commands; see section *File Manager (Data – Arrange)* on p. 4.29 ff.

OK to Save

OK to Save saves the current configuration in all function groups and test modes selected in the configuration tree to the configuration file specified via *Change Dest.*

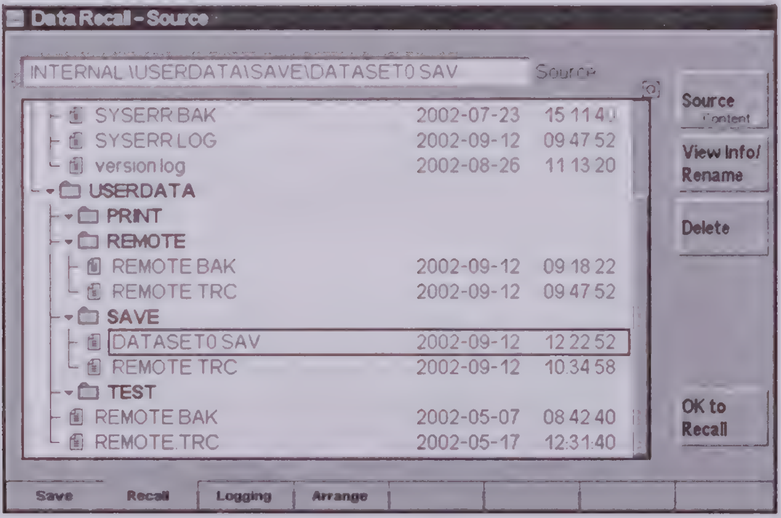
Note: *Saving only the configuration of the active function group is faster because no additional software modules must be loaded.*

Remote control
`MMEMory:SAVE:CURRent <FileName> [,<msus>]`
`MMEMory:SAVE[:ALL] <FileName> [,<msus>]`

Loading Saved Configurations (Data – Recall)

The *Recall* tab in the *Data* popup menu recalls and activates a configuration previously stored with the *Save* tab; see section current instrument settings to a configuration file (*.SAV); see section *Saving Configurations (Data – Save)* on p. 4.22 ff.

DATA →



```
INTERNAL \USERDATA\SAVE\DATASET0 SAV
    SYSERR BAK          2002-07-23   15 11 4
    SYSERR LOG          2002-09-12   09 47 52
    version log         2002-08-26   11 13 20
  USERDATA
    PRINT
    REMOTE
      REMOTE BAK        2002-09-12   09 18 22
      REMOTE TRC        2002-09-12   09 47 52
    SAVE
      DATASET0 SAV      2002-09-12   12 22 52
      REMOTE TRC        2002-09-12   10 34 58
    TEST
    REMOTE BAK          2002-05-07   08 42 40
    REMOTE.TRC          2002-05-17   12:31:40
```

Fig. 4-16 Data – Recall menu

The *View Info/Rename* and *Delete* softkeys are equivalent to the softkeys of the same name in the *Arrange tab;* see section *File Manager (Data – Arrange)* on p. 4.29.

File selection

The stored files can be selected from a tree view in the center of the menu. The tree can be expanded and compressed using the roll-key and the *ON/OFF* key (see Chapter 3, *Expanding menu tables*). By default, configuration files are stored in the directory *INTERNAL\USERDATA\SAVE* and with the file names DATASET?.SAV, where the question mark is replaced by a current number.

Source Content

Source/Content toggles between the directory view (see *Fig. 4-16 above*) and the overview of function groups and test modes contained in a configuration file (configuration tree); see *Dir. View/Content* softkey on p. 4.30.

The configuration tree can be used for a partial recall of instrument settings: On recalling a configuration file, only the settings in the function groups and test modes selected in the configuration tree are overwritten. By default all function groups and test modes stored in the configuration file are selected.

Remote control
–

OK to Recall

OK to Recall recalls the selected configuration file and activates the stored settings for the function groups and test modes selected in the configuration tree.

The active function group, test mode and measurement menu is stored with the *Base* system settings when a configuration file is created. As a consequence the behavior of the CMU after a recall depends on whether or not the *Base* system settings are also recalled:

- After a recall including the base system settings the CMU enters the function group, test mode and measurement menu stored in the configuration file.
- After a recall excluding the base system (or a recall of a configuration file without base system information) the CMU returns to its current function group.

Note: *Recalling only a configuration of the active function group is faster because no additional software modules must be loaded.*

Before recalling and activating a configuration file, the instrument checks whether the settings are compatible with its current hardware configuration and software versions. If an incompatibility is detected, the configuration file is not recalled and an error message is generated. Configuration files are upward compatible and can be re-used in later firmware versions.

Remote control

```
MMEMory:RECall:CURRent <FileName> [,<msus>]
MMEMory:RECall[:ALL] <FileName> [,<msus>]
```

Layer 3 Message Log (Data – Logging)

The *Logging* tab in the *Data* popup menu activates recording of the layer 3 messages transferred during a GSM-MS Signalling session and selects a destination file for this information.

DATA →

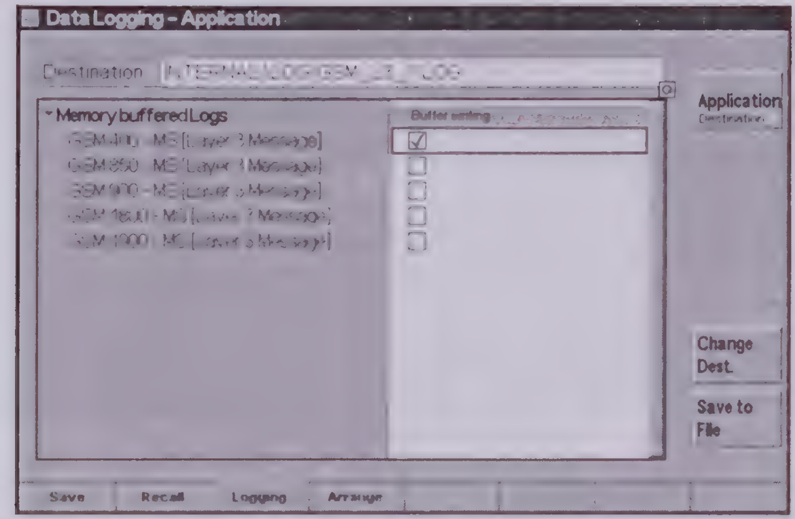
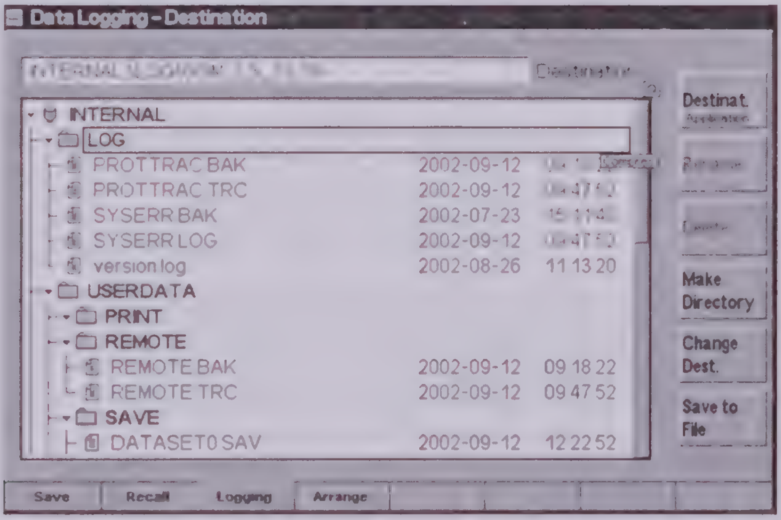

Data Logging - Application
Destination
Memory buffered Logs
GSM400 - MS [Layer 3 Message]
GSM850 - MS [Layer 3 Message]
GSM900 - MS [Layer 3 Message]
GSM1800 - MS [Layer 3 Message]
GSM1900 - MS [Layer 3 Message]
Buffer writing
☑
☐
☐
☐
☐
Application
Destination
Change Dest.
Save to File
Save
Recall
Logging
Arrange

Fig. 4-17 Data – Logging menu

Application
Destination

Application/Destination toggles between the overview of available GSM networks (see *Fig. 4-17 above*) and a view of the directories available for storing the log file (*.LOG). The *Destination* view is analogous to the *Arrange* tab; see section *File Manager (Data – Arrange)* on p. 4.29 ff.


Data Logging - Destination
Destination
Destinat.
Application
Make Directory
Change Dest.
Save to File
Save
Recall
Logging
Arrange

INTERNAL		
LOG		
PROTTRAC.BAK	2002-09-12	[illegible]
PROTTRAC.TRC	2002-09-12	[illegible]
SYSERR.BAK	2002-07-23	[illegible]
SYSERR.LOG	2002-09-12	[illegible]
version.log	2002-08-26	11:13:20
USERDATA		
PRINT		
REMOTE		
REMOTE.BAK	2002-09-12	09:18:22
REMOTE.TRC	2002-09-12	09:47:52
SAVE		
DATASET0.SAV	2002-09-12	12:22:52

Remote control
–

Buffer Writing The checkboxes in the *Buffer Writing* column control data recording in the five different GSM networks supported by the instrument.

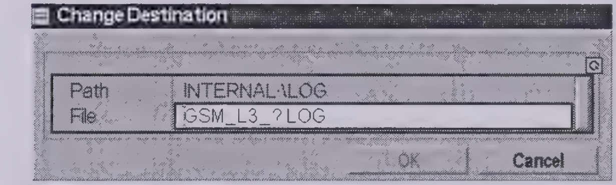
If buffer writing is enabled for a particular GSM network (box checked), the GSM layer 3 uplink and downlink messages transferred during a *GSM-MS Signalling* test session are stored in a ring buffer. The buffer size corresponds to approx. 3200 messages. Message types that are connected with information displayed in the CMU measurement menus, e.g. the MS receiver reports, are not recorded. Recording is continued even after a handover or a change of the network.

The contents of the ring buffer can be written to a binary file any time (even while *Buffer Writing* is enabled); see *Save to File* softkey below. Saving the buffer contents clears the buffer. On the other hand the buffer is not cleared when *Buffer Writing* is enabled.

Remote control:
The commands for the layer 3 message log belong to the *GSMxxx-MS Signalling* function groups:
`MMEMory:L3Msg:BWRiting ON | OFF`

Change Dest.

The *Change Dest.* softkey opens a dialog to specify the name and path of the created log file.



Path INTERNAL\LOG
File GSM_L3_?.LOG

Editing the *Change Destination* dialog is optional: By default, the CMU stores log files to the directory *INTERNAL\LOG* and uses the file names GSM_L3_?.LOG where the question mark is replaced by current numbers that are automatically incremented, starting with zero (auto-increment function). To create more than 10 different log files, another name or destination must be specified.

Selecting *OK to Save* closes the dialog window and stores the inputs made. Pressing *Cancel* or *Change Dest.* again without selecting *OK to Rename* closes the dialog box, discarding all inputs made.

Remote control
The commands for the layer 3 message log belong to the *GSMxxx-MS Signalling* function groups:
`MMEMory:L3Msg:CDEStination <FileName> [,<msus>]`

Save to File

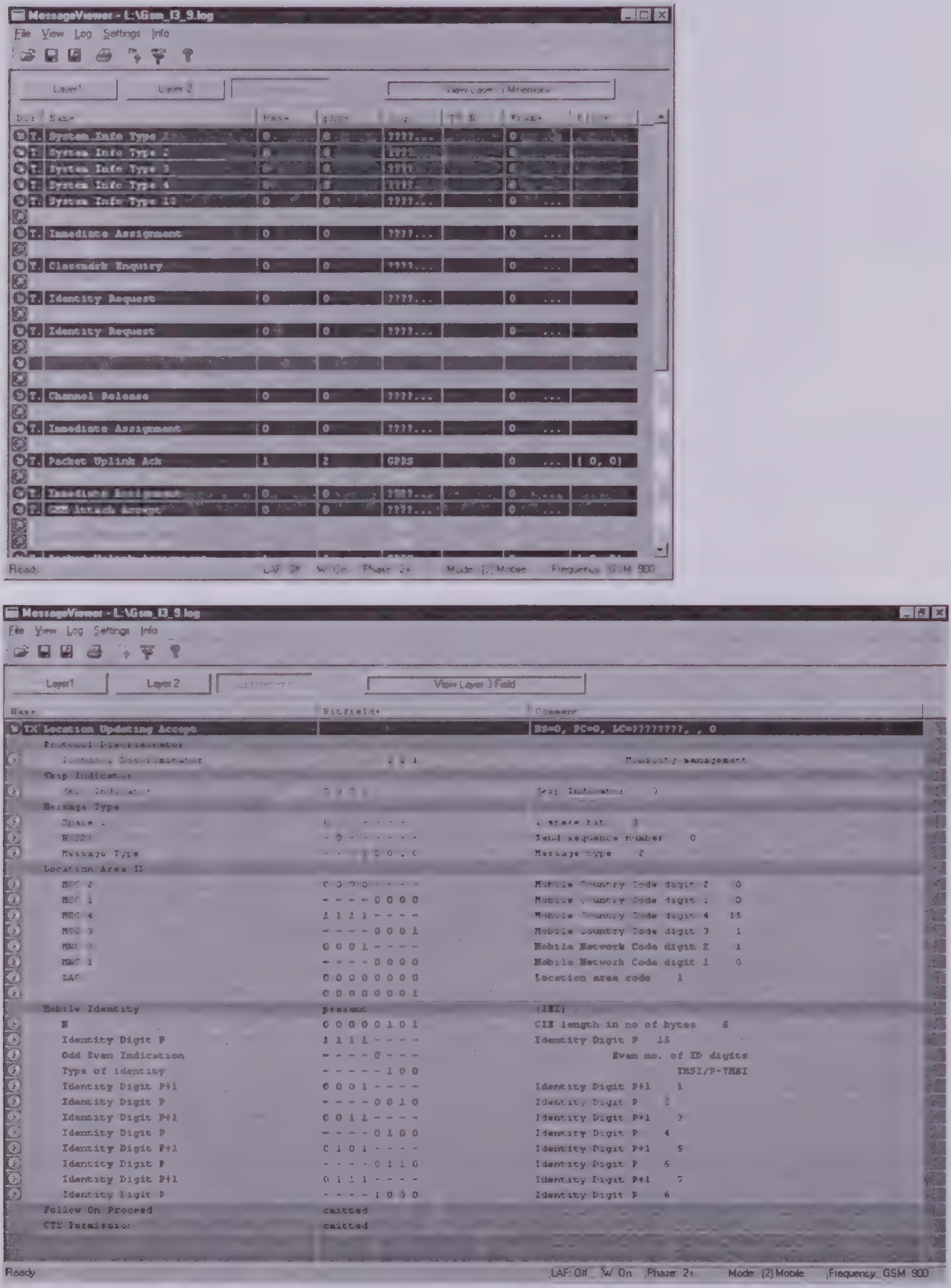
Save to File saves the current ring buffer content to the log file specified via *Change Dest.* and clears the ring buffer.

Note: *The contents of the ring buffer are also saved when the instrument is shut down, i.e. after pressing Alt+F4 on instruments equipped with a FMR 5 or during the normal shutdown process (ON/STANDBY key; "Shutdown in progress...") on instruments equipped with a FMR 6. To distinguish files created during shutdown from ordinary log files they are named GSM_L3_?.SAV where the ? is auto-incremented.*

Remote control
The commands for the layer 3 message log belong to the *GSMxxx-MS Signalling* function groups:
`MMEMory:L3Msg:SAVe <FileName> [,<msus>]`
`MMEMory:L3Msg:BEMPty?`

Transfer and Evaluation of Log Files

A log file can be transferred to a PC using the functions of the *Arrange* tab (see section *File Manager (Data – Arrange)* on p. 4.29 ff.) or via GPIB bus using the `MMEMory:DATA` command. Rohde & Schwarz provides an evaluation software tool for log files, the *Message Viewer* (option R&S CMU-Z49; the extended version R&S CRTU GP01, stock no. 1139.7590.02, allows to edit layer 3 messages). After loading the log file into the *Message Viewer,* the information can be evaluated as shown in the following examples. For more information please refer to the operating manual or help for the *Message Viewer*.



```
T. System Info Type 1            0   0   ????...      0  ...
T. System Info Type 2            0   0   ????...      0
T. System Info Type 3            0   0   ????...      0
T. System Info Type 4            0   0   ????...      0
T. System Info Type 13           0   0   ????...      0  ...
T. Immediate Assignment          0   0   ????...      0  ...
T. Classmark Enquiry             0   0   ????...      0  ...
T. Identity Request              0   0   ????...      0  ...
T. Identity Request              0   0   ????...      0  ...
T. Channel Release               0   0   ????...      0  ...
T. Immediate Assignment          0   0   ????...      0  ...
T. Packet Uplink Ack             1   2   GPRS         0  ...  ( 0, 0)
T. Immediate Assignment          0   0   ????...      0  ...
T. GMM Attach Accept             0   0   ????...      0  ...
```

```
Name                               Bitfields          Comment
TX Location Updating Accept                           BS=0, PC=0, LC=????????, , 0
  Protocol Discriminator
    Protocol Discriminator               0 1 0 1                Mobility management
  Skip Indicator
    Skip Indicator               0 0 0 0              Skip Indicator    0
  Message Type
    Spare 1                      0 - - - - - - -      1 spare bit    0
    N(SD)                        - 0 - - - - - -      Send sequence number    0
    Message Type                 - - 0 0 0 0 1 0      Message type    2
  Location Area ID
    MCC 2                        0 0 0 0 - - - -      Mobile Country Code digit 2    0
    MCC 1                        - - - - 0 0 0 0      Mobile Country Code digit 1    0
    MCC 4                        1 1 1 1 - - - -      Mobile Country Code digit 4    15
    MCC 3                        - - - - 0 0 0 1      Mobile Country Code digit 3    1
    MNC 2                        0 0 0 1 - - - -      Mobile Network Code digit 2    1
    MNC 1                        - - - - 0 0 0 0      Mobile Network Code digit 1    0
    LAC                          0 0 0 0 0 0 0 0      Location area code    1
                                 0 0 0 0 0 0 0 1
  Mobile Identity                present              (IEI) :
    N                            0 0 0 0 0 1 0 1      CIE length in no of bytes    5
    Identity Digit P             1 1 1 1 - - - -      Identity Digit P   15
    Odd Even Indication          - - - - 0 - - -               Even no. of ID digits
    Type of identity             - - - - - 1 0 0                        TMSI/P-TMSI
    Identity Digit P+1           0 0 0 1 - - - -      Identity Digit P+1    1
    Identity Digit P             - - - - 0 0 1 0      Identity Digit P    2
    Identity Digit P+1           0 0 1 1 - - - -      Identity Digit P+1    3
    Identity Digit P             - - - - 0 1 0 0      Identity Digit P    4
    Identity Digit P+1           0 1 0 1 - - - -      Identity Digit P+1    5
    Identity Digit P             - - - - 0 1 1 0      Identity Digit P    6
    Identity Digit P+1           0 1 1 1 - - - -      Identity Digit P+1    7
    Identity Digit P             - - - - 1 0 0 0      Identity Digit P    8
  Follow On Proceed              omitted
  CTS Permission                 omitted
```

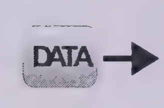
Fig. 4-18 Evaluation of log files

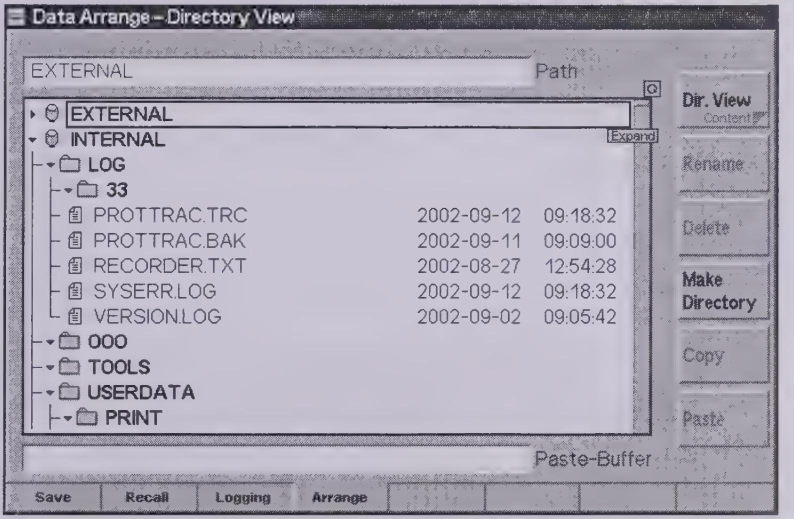
File Manager (Data – Arrange)

The *Arrange* tab in the *Data* popup menu manages the files in the internal and external memories that can be used for mass storage. The menu is particularly useful for handling files containing user data such as:

- Screenshots (*.wmf or printer format, see section *Print Menu (PRINT Menu)* on p. 4.4 f.)
- Log files (special binary *.log format, see section *Layer 3 Message Log (Data – Logging)* on p. 4.25 ff.)
- Remote report files (ASCii text files, see description of the remote screen in Chapter 5)

An extended file management functionality is available in remote control; see `MMEMory` system in Chapter 6.





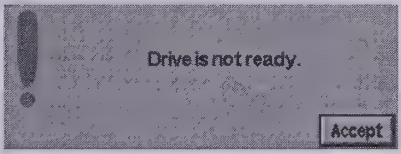
```
EXTERNAL
▸ EXTERNAL
▾ INTERNAL
  ├▾ LOG
  │ ├▾ 33
  │ ├ PROTTRAC.TRC      2002-09-12   09:18:32
  │ ├ PROTTRAC.BAK      2002-09-11   09:09:00
  │ ├ RECORDER.TXT      2002-08-27   12:54:28
  │ ├ SYSERR.LOG        2002-09-12   09:18:32
  │ └ VERSION.LOG       2002-09-02   09:05:42
  ├▾ 000
  ├▾ TOOLS
  ├▾ USERDATA
  │ ├▾ PRINT
```

Fig. 4-19 Data – Arrange menu

File selection

The stored files can be selected from a tree view in the center of the menu. The tree can be expanded and compressed using the roll-key and the *ON/OFF* key (see Chapter 3, *Expanding menu tables*). It starts from the nodes for the *EXTERNAL* and *INTERNAL* mass storage devices:

EXTERNAL Root directory of the external storage device. Depending on the instrument configuration, this can be a floppy disk or a PCMCIA memory card, inserted in slot 0 (right side) of the PCMCIA interface. The *Data* menu does not discriminate between the two slots. If an attempt is made to expand the *EXTERNAL* directory while no external storage device is present, the CMU displays the following message:


Drive is not ready.

➢ *Accept* the message, insert a suitable storage device and try again to expand the *EXTERNAL* directory and view its contents.

INTERNAL Root directory of the section on the internal hard disk that is reserved for mass storage.

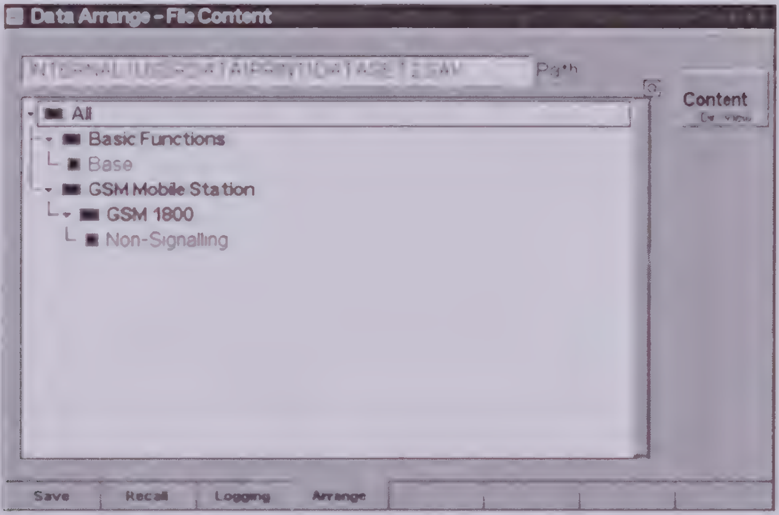
File indication / Paste Buffer

The output field above the tree view shows the path and name of the selected file. The *Paste Buffer* field below the tree view shows the path and name of a file that has been cut or copied to be pasted into another directory.

Remote control
`MMEMory:MSIS INTernal | EXTernal`

Dir. View
Content

Dir. View/Content toggles between the directory view (see *Fig. 4-19 above*) and the overview of function groups and test modes contained in a configuration file (*.SAV). The *Content* view is available for configuration files only:



The *Content* view shows the path and name of the configuration file and all function groups and test modes contained in the file. The tree view is for information only. It is analogous to the trees in the *Reset* menu (see section *Reset of Instrument Settings (RESET Key)* on p. 4.3 ff.) and in the *Save* and *Recall* tabs of the *Data* menu, however, it only shows the function groups and test modes actually contained in the configuration file so that all rectangular symbols are black.

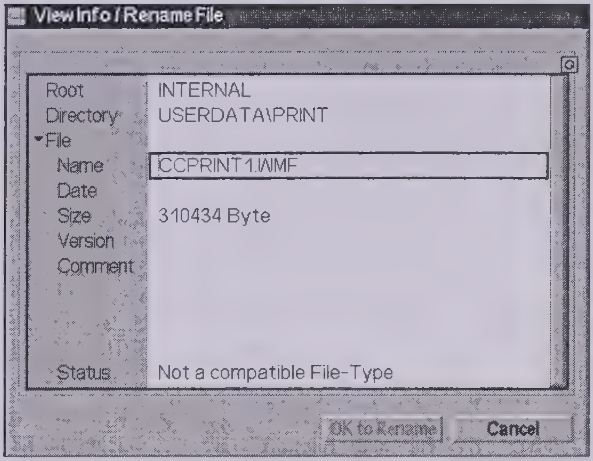
Remote control
–

View Info
Rename

The *View Info/Rename* softkey opens a dialog to display and edit file information or assign a new name to the selected file or to a subdirectory.

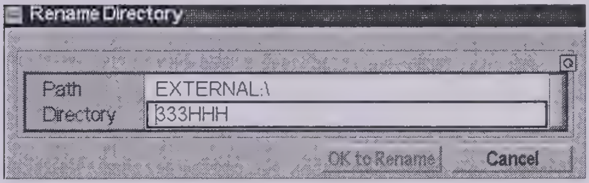
The labeling of the softkey and its function depends on the selected node in the directory view:

- If a file is selected the softkey reads *View Info/Rename*. It opens a popup window showing the *Root* directory, the *Directory* plus other file information. The file *Name* and a *Comment* to be stored with the file can be edited. This can be done with the *DATA* keys on the front panel and the auxiliary editor (see Chapter 3) or even more conveniently using an external keyboard. The *Status* shows either *File OK* (for configuration files *.SAV) or *Not a compatible file type* (for all other file types).



Root INTERNAL
Directory USERDATA\PRINT
File
Name CCPRINT1.WMF
Date
Size 310434 Byte
Version
Comment
Status Not a compatible File-Type

- If a directory is selected, no particular information is needed so the softkey reads *Rename.* It opens a popup window to rename and move the directory by editing the *Path* and the *Directory* name. The path can be entered according to DOS conventions, if so desired. *Rename* is disabled (grayed) while the *EXTERNAL* and *INTERNAL* root directories or the reserved directories *Log, Userdata, Print, Remote, Save* are selected (the reserved directories are used internally to store important info files). Moreover, the maximum number of directory levels below the *EXTERNAL* and *INTERNAL* root directories is 5.



Path EXTERNAL:\
Directory 333HHH

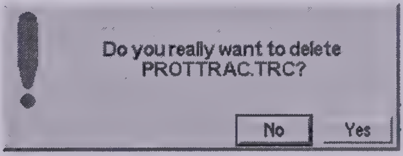
Selecting *OK to Rename* closes the dialog windows and renames the file or directory. Pressing *Cancel* or *View Info/Rename* again without selecting *OK to Rename* closes the dialog box without renaming the file.

Remote control

```
MMEMory:INFO? <FileName> [,<msus>]
MMEMory:MOVE <FileSource>[,<msus1>], <FileDest> [,<msus2>]
```

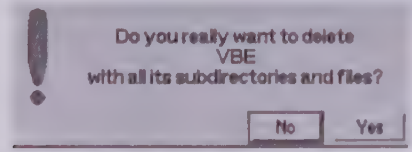
Delete

The *Delete* softkey deletes the selected file or directory. Before an individual file is deleted, the CMU generates a warning:



Do you really want to delete PROTTRAC.TRC?

Before a directory is deleted, the CMU generates a similar warning:



Do you really want to delete
VBE
with all its subdirectories and files?

Selecting *Yes* deletes the file or directory; selecting *No* closes the warning messages without deleting.

Remote control
`MMEMory:DELete <FileName>, [INTernal | EXTernal]`
`MMEMory:RMDir <DirName>, [INTernal | EXTernal]`

Make Directory

The *Make Directory* softkey creates a new directory. The name and path of the new directory are entered into a *Make Directory* dialog box, see *Rename Directory* above.

Remote control
`MMEMory:MKDir <Dir_Name>[,<msus>]`

Copy

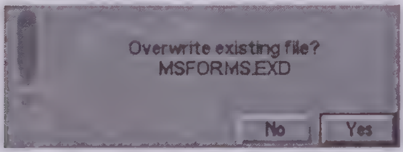
The *Copy* softkey stores the selected file or directory into the *Paste Buffer* so it can be copied to other directories or storage devices (see *Paste* softkey below). The original file or directory is not deleted, so the *Copy* function duplicates a file or a directory with all its contents.

Remote control
No direct equivalent. To replace the Copy/Paste mechanism use the command
`MMEMory:COPY <FileSource>[,<msus1>], <FileDest> [,<msus2>]`

Paste

- The *Paste* softkey stores the file or directory copied into the *Paste Buffer* to the current directory. It is disabled (grayed) if the *Paste Buffer* is empty. A copied file can be stored several times to different directories and storage devices. Pasting the file does not affect the *Paste Buffer*.

If the current directory contains a file or subdirectory with the same name; a warning is generated:



Overwrite existing file?
MSFORMS.EXD

Selecting *Yes* overwrites the existing file or directory; selecting *No* closes the warning message without pasting the content of the buffer.

Remote control
No direct equivalent. To replace the Copy/Paste mechanism use the command
`MMEMory:COPY <FileSource>[,<msus1>], <FileDest> [,<msus2>]`

4 Functions

RF Measurements (RF)

This section describes the measurement and configuration menus of function group *RF*. It is organized as follows:

- Configuration of the RF output signal and RF analyzer settings *(Analyzer/Generator).*
- Measurement menus *(Power* and *Spectrum):* Measurement menus, results, configuration menus.
- General configurations *(Connection Control).*

The most important menus of the *RF* function group are shown in an overview at the end of chapter 3 in the present CMU manual.

Analyzer/Generator Menu

The main menu *Analyzer/Generator* configures the RF generator and analyzer and displays the power of the received RF signal.

The measurement control softkey *Analyzer Power* changes to *Power Meter Freq. Sel.,* depending on the application selected. This softkey controls the measurement, indicates its status *(RUN | HLT | OFF)* and opens the configuration menu *Analyzer/Generator Configuration*. The hotkeys associated to the measurement control softkey define the scope of the *Analyzer/Generator* measurement.

The other softkeys on the right side are combined with various hotkeys (e.g. the hotkeys *Frequency* and *RBW* belong to the softkey *Analyzer Settings).* The softkey/hotkey combinations provide test settings and switch over between different measurements.

The *RF* function group provides different types of power measurements. All power measurements are performed at fixed frequency. They differ in their measurement principle and filter settings, in the statistical evaluation and the display of results.

Analyzer Power	*Analyzer Power* is an application in the *Analyzer/Generator* menu. The measurement yields the average power of an RF input signal over a sweep; see section *Measurement Results* on p. 4.37 ff. A wide range of measurement filters including a wideband filter is available. The accuracy of the *Analyzer Power* (including the wideband power) measurement is enhanced if the center frequency of the analyzer matches the frequency of the measured signal. The characteristics of the *Analyzer Power* measurement makes it particularly suitable for the analysis of CW signals where no measurement curves are needed.
Power Meter Freq. Sel.	*Power Meter Freq. Sel.* is the second application in the *Analyzer/Generator* menu. The measurement yields the average, minimum and maximum power of an RF input signal over a sweep plus a statistical evaluation over several consecutive sweeps; see section *Measurement Results* on p. 4.37 ff. A wide range of measurement filters including the filters specified for TDMA and CDMA conformance tests is available. The measurement is always frequency selective; no wideband filter is provided. The measurement time depends on the filter bandwidth but never exceeds the order of magnitude of 100 ms for a single sweep. The frequency of the RF signal is also measured, provided that is close enough to the selected measurement frequency. The characteristics of the *Power Meter Freq. Sel* measurement makes it particularly suitable for the analysis of CW signals where no measurement curves are needed.
Pow. Meter Wideband	*Pow. Meter Wideband* is displayed in the *RF* connector tab of the *Connection Control* menu. The measurement is performed at the RF Frontend of the CMU and yields the peak

power of the input signal inside a wide frequency range. For modulated RF signals, the result of the wideband power measurement depends on the modulation characteristics.

The main purpose of the measurement is to indicate whether an input signal is available and whether it is advisable to change the *Max Level* settings.

Power vs. Time The *Power vs. Time* measurement yields the power of the RF input signal over a variable time range. The result is displayed in a graphical diagram; see section *Power* on p. 4.40 ff.

The measurement is performed at fixed frequency. A wide range of Gaussian measurement filters is available. The *Power vs. Time* measurement can be used to analyze an RF signal with variable power, e.g. a burst signal.

Types of settings The purpose of the *Analyzer/Generator* menu is to provide quick access to the most common RF analyzer and generator settings and to present the basic power results at a glance. Two measurement applications *Analyzer Power* or *Power Meter Freq. Sel.* can be selected with the *Application* softkey. The remaining softkeys/hotkey combinations provide two different types of settings:

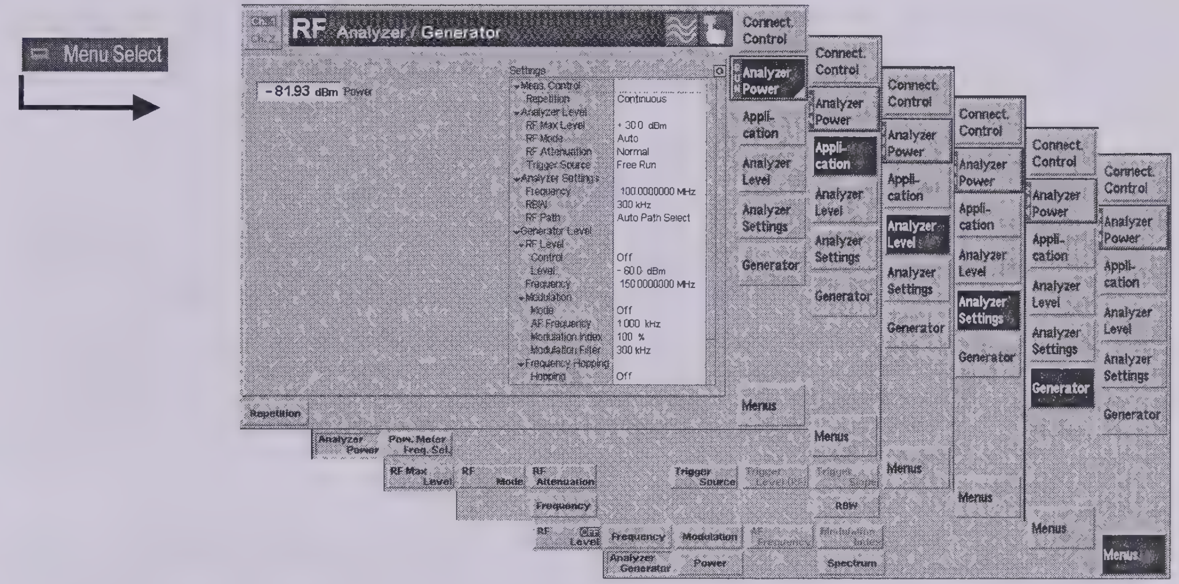
General settings are valid for all applications of the RF function group. Changing general settings in any application will have an impact on all measurements and applications of the function group. All general settings are also provided in the *Connection Control* menu (see p. 4.58 ff.). Examples of general settings are the *RF Max. Level* and the trigger settings (softkey *Analyzer Level)* and the configuration of the RF generator (softkey *Generator)*.

Specific settings are relevant for one application only, or they can be set independently for several applications. Changing specific settings in an application will not affect the other measurements and applications of the function group. No specific settings are provided in the *Connection Control* menu (see p. 4.58 ff.). Examples of specific settings are the *Repetition* mode (to be set independently for all applications) and *Statistic Count* (not relevant for the *Analyzer Power* application).

Measurement results The output fields in the left half of the *Analyzer/Generator* menu show the current measurement results. The results depend on the selected application. They are described in detail in section *Measurement Results* on p. 4.37 f.

The results displayed in the *Analyzer/Generator* menu represent only a small fraction of the power results that the CMU is able to acquire. More results are displayed in the *Power* and *Spectrum* measurement menus; see sections *Power* on p. 4.40 ff. and *Spectrum* on p. 4.48 ff. In particular, the *Power* and *Spectrum* menus show the results as a function of time and frequency.

The main menu *Analyzer/Generator* is opened from the main menu *Menu Select* (with associated key at front of instrument). It can also be accessed from the other measurement menus of the function group *RF* via the *Ana./Gen.* hotkey.


Menu Select
RF Analyzer / Generator
-81.93 dBm Power
Connect. Control
Analyzer Power
Appli-cation
Analyzer Level
Analyzer Settings
Generator
Menus
Repetition
Analyzer Power
Pow. Meter Freq. Sel.
RF Max Level
RF Mode
RF Attenuation
Trigger Source
Trigger Level
Trigger Slope
Frequency
RBW
RF Level
Frequency
Modulation
AF Frequency
Modulation Index
Analyzer Generator
Power
Spectrum

Settings	
Meas. Control	
Repetition	Continuous
Analyzer Level	
RF Max Level	+ 30.0 dBm
RF Mode	Auto
RF Attenuation	Normal
Trigger Source	Free Run
Analyzer Settings	
Frequency	100.0000000 MHz
RBW	300 kHz
RF Path	Auto Path Select
Generator Level	
RF Level	
Control	Off
Level	- 60.0 dBm
Frequency	150.0000000 MHz
Modulation	
Mode	Off
AF Frequency	1.000 kHz
Modulation Index	100 %
Modulation Filter	300 kHz
Frequency Hopping	
Hopping	Off

Fig. 4-19 Measurement menu Analyzer / Generator

Test Settings

The settings for the *Analyzer/Generator* menu are accessible via softkey/hotkey combinations. If a softkey (located in the softkey bar on the right side of the menu) is selected and an associated hotkey (displayed across the bottom of the menu) is pressed, a popup window indicating the current setting and enabling an entry will appear.

Example:

Analyzer Settings

The *Analyzer Settings* softkey displays a hotkey bar including the hotkey labeled *Frequency*.

Frequency

The *Frequency* hotkey opens the input window *Frequency*.

Frequency
856.2 MHz

Input windows indicate the current parameter value (in this case: the current RF input frequency) or a list of the possible settings. Parameters are changed by

- Overwriting/incrementing numerical values (for numerical parameters)
- Selecting from the list of parameters (for select parameters)

Each *Analyzer/Generator* application is controlled by means of the measurement control softkey below the *Connect. Control* softkey and the associated hotkeys.

Analyzer Power

The *Analyzer Power* softkey (which changes to *Power Meter Freq. Sel.*, depending on the application selected) controls the measurement application and indicates its state *(RUN | HLT | OFF)*. This state can be changed after softkey selection (pressing once) by means of the *ON/OFF* key or the *CONT/HALT* key. The state can be set independently for all three applications.

Remote control

```
INITiate:RFANalyzer
ABORt:RFANalyzer
STOP:RFANalyzer
CONTinue:RFANalyzer
FETCh:RFANalyzer:STATus?
FETCh[:SCALar]:RFANalyzer:POWer[:RESult]? etc.
```

Measurement configuration

The configuration menus for the RF analyzer and generator are directly accessible from the *Analyzer/Generator* menu: Pressing the *Analyzer Power* softkey twice opens the popup menu *Analyzer/Generator Configuration* (see page 4.38 ff.).

Besides a number of hotkeys defining the scope of the measurement are associated to the *Analyzer Power* softkey. The corresponding settings are specific to the *Analyzer/Generator* menu and also provided in the *Control* tab of the *Analyzer/Generator Configuration* menu; see section *Analyzer/Generator Configuration* on p. 4.38 ff.

Appli-cation

The *Application* softkey selects the measurement application. The measurement control softkey (second softkey below *Connect. Control)* indicates the current application. Some of the hotkeys associated to the different softkeys, the *Setup* table, and the results in the *Analyzer/Generator* menu also vary as a function of the application. Details about the measurements and the results are explained in section *Measurement Results* on p. 4.37 f.

Analyzer Power

The *Analyzer Power* hotkey selects the measurement of the peak power using a filter with variable bandwidth or a wideband filter. In this application no statistical evaluation of the results is provided.

Remote control
The *Analyzer Power* application corresponds to the `RFANalyzer` subsystem.

Pow. Meter Freq. Sel.

The *Pow. Meter Freq. Sel.* hotkey selects the measurement of the peak and average power using a wide selection of narrow-band (and therefore frequency selective) filters. In this application a statistical evaluation of the results is provided.

Remote control
The *Pow. Meter Freq. Sel.* application corresponds to the `NPOWer` subsystem.

Analyzer Level

The *Analyzer Level* softkey controls the level in the RF input signal path and provides the trigger settings for the current measurement.

The input level and trigger settings are general settings and therefore also provided in the *Connection Control* menu. They are described in more detail in sections *Analyzer Settings – Table-Oriented Version* on page 4.59 and *Trigger (Connection Control – Trigger)* on p. 4.72 ff.

Analyzer Settings

The *Analyzer Settings* softkey determines the center frequency of the RF analyzer and the resolution bandwidth of the measurement filter. The settings are specific to the *Analyzer/Generator* menu and also provided in the *Control* tab of the *Analyzer/Generator Configuration* menu; see section *Analyzer/Generator Configuration* on p. 4.38 ff.

Generator
Tx **Aux Tx**

The *Generator* softkey configures the RF signals generated. The generator settings are general settings and therefore also provided in the *Connection Control* menu. They are described in more detail in section *Generator Settings (Connection Control – Generator)* on p. 4.61 ff.

The *RF Level* hotkey is also used to switch the RF generator on and off.

If option R&S CMU-B95, *Second RF Generator,* is fitted, the *Generator* softkey toggles between the primary RF signal *(Tx)* and the auxiliary RF signal *(Aux Tx)* settings. The properties of the *Aux Tx* signal are also described in section *Generator Settings (Connection Control – Generator)* on p. 4.61 ff

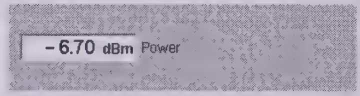
Settings table

The *Settings* table in the right half of the *Analyzer/Generator* menu gives an overview of the measurement settings belonging to the current application. It changes when a different application is selected. The rotary knob scrolls and expands the *Settings* table.

Measurement Results

The results displayed in the *Analyzer/Generator* menu depend on the selected application. All results are obtained at a definite frequency and resolution bandwidth; see *Analyzer Settings* softkey on p. 4.36.

Analyzer Level:

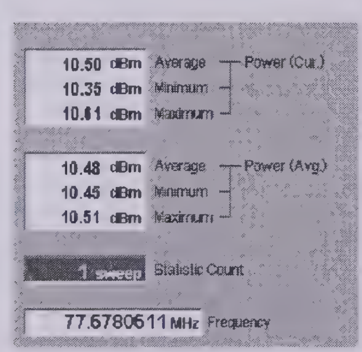


– 6.70 dBm Power

The result for the *Analyzer Level* application appears in a single output field.

The indicated *Power* is the power of the RF input signal measured at the selected frequency and RBW and averaged over a basic evaluation period/sweep of 4096 samples. The result is updated after each sweep.

Pow. Meter Freq. Sel.:



10.50 dBm Average
10.35 dBm Minimum
10.61 dBm Maximum
Power (Cur.)

10.48 dBm Average
10.45 dBm Minimum
10.51 dBm Maximum
Power (Avg.)

1 sweep Statistic Count

77.6780611 MHz Frequency

The results for the frequency selective power meter *(Pow. Meter Freq. Sel.)* application are displayed in several groups of output fields. All results are obtained at the selected frequency and RBW. The statistical evaluation is based on a basic evaluation period/sweep of 4096 samples and on the statistics cycle *(Statistic Count)* defined in the configuration menu (see section *Analyzer/Generator Configuration* on p. 4.38 ff.; for a general description of statistical evaluations in the CMU refer to Chapter 3, section *General Settings)*.

Power (Curr.)	Average, minimum and maximum power of the RF input signal in the current sweep
Power (Avg.)	Average, minimum and maximum of the *Power (Curr.)* values: The *Maximum (Minimum)* value is the largest (smallest) power ever measured in the current measurement. *Average* is the average over all *Average – Power (Curr.)* values in the current measurement, obtained according to the averaging rules described in Chapter 3, section *General Settings.*
Statistic Count	Number of sweeps per statistics cycle. The colored bar indicates the relative measurement progress in the statistics cycle
Frequency	Frequency of the RF input signal. The frequency can be measured with an accuracy of 0.1 Hz.

Analyzer/Generator Configuration

The popup menu *Analyzer/Generator Configuration* configures the RF analyzer measurements. It is opened by pressing the *Analyzer Power* measurement control softkey in the Analyzer/Generator menu twice.

In the *Control* tab of the *Analyzer/Generator Configuration* menu both power measurement applications of the *Analyzer/Generator* menu can be configured independently. The tab defines:
The center *Frequency* of the RF analyzer

The Repetition mode

The *Statistic Count* for the measurement (for the *Power Meter Freq. Sel.* measurement only)

The *Resolution Bandwidth* of the measurement filter

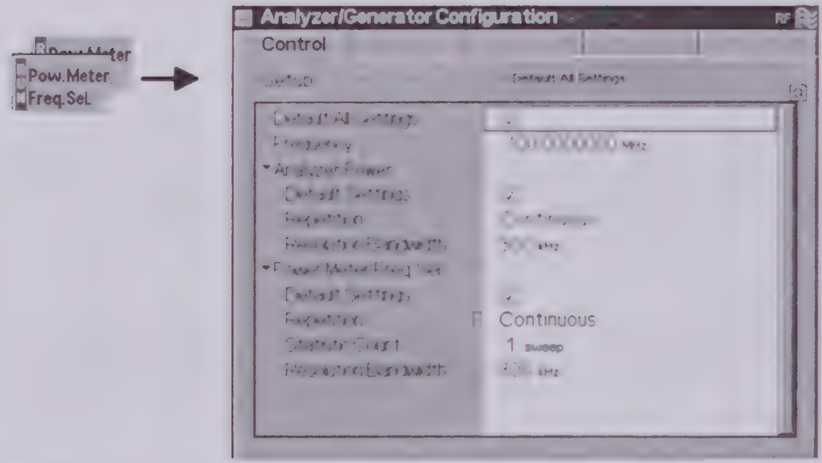


Fig. 4-20 Analyzer/Generator Configuration – Control

Default Settings The *Default All Settings* switch assigns default values to all settings in the *Control* tab (the default values are quoted in the command description in chapter 6 of this manual). In addition, default switches for the individual applications are provided.

Remote control

Frequency *Frequency* defines the center frequency of the RF analyzer. This setting is valid for both *Analyzer/Generator* measurement applications.

Remote control
`[SENSe:]RFANalyzer:FREQuency <Frequency>`

Resolution Bandwidth *Resolution Bandwidth* defines the resolution bandwidth of the analyzer. The nominal resolution bandwidth is the 3-dB bandwidth of the measurement filter. The bandwidths available depend on the measurement application:
For both applications, a list of Gaussian filters with discrete bandwidths between 10 Hz and 1 MHz is available. The frequencies in the list are given by $1x10^n$ Hz, $2x10^n$ Hz, $3x10^n$ Hz, $5x10^n$ Hz where n=1 to 5. In addition the value 1 MHz is provided.

The *Analyzer Power* measurement can be performed with a *WIDE* resolution bandwidth (denoting measurement at the front end with no restriction of the analyzer frequency and level). The wide-band measurement is most accurate if the correct center frequency is set.

The *Pow. Meter Freq. Sel.* measurement can be performed with the root-raised cosine filter specified in standard TIA/EIA-136.xxx *(TDMA* filter) or with an 1.4 MHz bandpass filter specified for CDMA measurements *(CDMA* filter).

Resolution bandwidths for the *Power* and *Spectrum* measurements can be set independently (pp. 4.40, 4.49).

Remote control

```
[SENSe:]RFANalyzer:BWIDth[:RESolution] <Bandwidth>
[SENSe:]NPOWer:BWIDth[:RESolution] <Bandwidth>
```

Repetition

Repetition determines the repetition mode. Repetition modes for the applications *Analyzer Power* and *Power Meter Freq. Sel.* can be set independently.

Single Shot	Single-shot measurement: the measurement is stopped after one sweep comprising 4096 samples. A stopped measurement is indicated by the status display *HLT* in the *Power* softkey.
Continuous	Continuous measurement: The CMU measures continuously until the measurement is explicitly stopped via the measurement control softkey in the graphical measurement menu (see *Analyzer Power* softkey on p. 4.35). The measurement results are valid after one sweep; however, the measurement is continued, and the output is continuously updated. An ongoing measurement is indicated by the status display *RUN* in the *Power* softkey.

Single shot should always be selected if only a single measurement result is required under fixed conditions. The continuous measurement is suitable for monitoring the evolution of a measured quantity in time, for example for adjustments.

Note: *In remote mode, the counting measurement (counting mode) is available as a further repetition mode with a defined number of measurement cycles to be performed, see chapter 6 of this manual.*

Remote control

```
CONFigure:RFANalyzer:CONTrol:REPetition
      CONTinuous | SINGleshot | 1 ... 10000,NONE,<Stepmode>
CONFigure:NPOWer:CONTrol:REPetition
      CONTinuous | SINGleshot | 1 ... 10000,NONE,<Stepmode>
```

Statistic Count

Statistic Count defines how many sweeps are combined to form one statistics cycle. Each sweep consists of 4096 samples. This setting is available for the *Power Meter Freq. Sel.* application; for *Analyzer Power* measurements the *Statistic Count* is always equal to one.

1 to 1000 sweeps	Number of sweeps per statistics cycle

The settings *1* and *OFF* (press *ON/OFF* key) are equivalent. A statistics cycle determines the duration of single-shot measurements (see Chapter 3, section *General Settings*).

Remote control

```
CONFigure:NPOWer:CONTrol:STATistics  1 ... 1000 | NONE
```

Power vs. Time Measurement

The menu group *Power* is designed to measure the RF signal power as a function of time (oscillographic representation measured at a specific frequency, e.g. for burst analysis). The popup menu *Power Configuration* is used for configuration of the measurements; the measurement results are displayed in the graphical measurement menu *Power*.

Note: *The RF function group provides a wide selection of power measurements. For an overview see section Analyzer/Generator on p.* 4.33 *ff.*

Measurement Menu (Power)

The graphical measurement menu *Power* displays the results of the power measurement in the time domain.

The main softkey *Power* controls the measurement, indicates its status *(RUN | HLT | OFF)* and opens the configuration menu *Power Configuration*. The hotkey associated to the main softkey define the scope of the *Power* measurement.

The other softkeys to the right of the test diagram are combined with various hotkeys (e.g. the hotkeys *Frequency* and *RBW* belong to the softkey *Analyzer Settings)*. The softkey/hotkey combinations provide test settings and display configurations.

The measurement menu *Power* is opened from the main menu *Menu Select* (with the associated key at the front of the instrument) or using the *Power* hotkey.

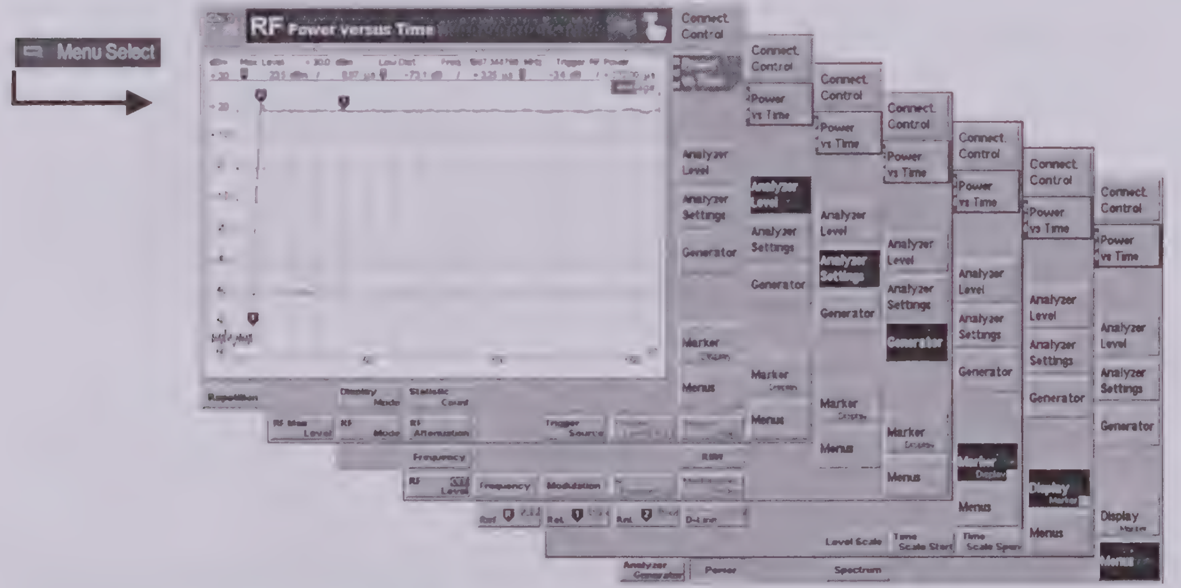

Menu Select
RF Power versus Time
Connect Control
Power vs Time
Analyzer Level
Analyzer Settings
Generator
Marker Display
Menus
Display Marker
Repetition
Display Mode
Statistic Count
RF Max Level
RF Mode
RF Attenuation
Trigger Source
Frequency
RBW
RF Level
Frequency
Modulation
Ref.
Rel.
Abs.
D-Line
Level Scale
Time Scale Start
Time Scale Span
Analyzer Generator
Power
Spectrum

Fig. 4-21 Measurement menu Power

Test settings

The basic settings for the *Power* measurement are directly accessible from the measurement menu via softkey/hotkey combinations. The entry of values is described in section *Test Settings* on p. 4.35 ff.

Some of the basic settings are also accessible from the *Power Configuration* popup menu. They are explained in more detail in the *Measurement Configurations (Power Configuration)* section on page 4.45 ff.

Power vs Time

The *Power vs Time* softkey controls the power measurement and indicates its status *(RUN | HLT | OFF)*. This status can be changed after softkey selection (pressing once) by means of the *ON/OFF* key or the *CONT/HALT* key.

Remote control
`INITiate:POWer; ABORt:POWer; STOP:POWer; CONTINUE:POWer`
`FETCh:POWer:STATus?`

Measurement configuration

Pressing the *Power vs Time* softkey twice opens the popup menus *Power Configuration* (see page 4.45). Besides, the measurement control softkey provides hotkeys to define the scope of the measurement. All these settings are described in more detail in section *Measurement Configurations (Power Configuration)* section on page 4.45 ff.

Analyzer Level

The *Analyzer Level* softkey controls the level in the RF input signal path and provides the trigger settings for the current measurement.

The input level and trigger settings are general settings and therefore also provided in the *Connection Control* menu. They are described in more detail in sections *Analyzer Settings – Table-Oriented Version* on page 4.59 and *Trigger (Connection Control – Trigger)* on p. 4.72 ff.

Analyzer Settings

The *Analyzer Settings* softkey determines the center frequency of the RF analyzer and the resolution bandwidth of the measurement filter. The settings are specific to the *Power* menu and also provided in the *Control* tab of the *Power Configuration* menu; see section *Measurement Configurations (Power Configuration)* section on page 4.45 ff.

Generator Tx Aux Tx

The Generator softkey configures the RF signals generated. The generator settings are general settings and therefore also provided in the Connection Control menu. They are described in more detail in section *Generator Settings (Connection Control – Generator)* on p. 4.61 ff.

The RF Level hotkey is also used to switch the RF generator on and off.

If option R&S CMU-B95, *Second RF Generator*, is fitted, the *Generator* softkey toggles between the primary RF signal *(Tx)* and the auxiliary RF signal *(Aux Tx)* settings. The properties of the *Aux Tx* signal are also described in section *Generator Settings (Connection Control – Generator)* on p. 4.61 ff

Marker Display

The *Marker/Display* softkey positions up to 3 markers and a D-line in the test diagram and displays their values.

If pressed once again, the selected Marker/Display softkey changes to the *Display/Marker* softkey, see below.

Markers are graphical tools for marking points on the measurement curve and for numerical output of measured values. The measurement menu Power provides a reference marker and two further markers which permit to measure differences (delta marker 1 and 2).
The coordinates of the three markers are indicated in the format Ordinate value (level)/abscissa value (time) in a parameter line above the test diagram. The position of the reference marker is expressed in absolute units (level in dBm and time in bits), the delta marker by absolute or relative values (relative level in dB or time differences from the

	reference marker).
D-line	The D-line (display line) is a horizontal line that can be positioned to mark and read out an arbitrary level in the test diagram.

Ref R

The hotkey *Ref. R* switches the reference marker on or off (use the *ON/OFF* key).

The reference marker is represented by the symbol R in the test diagram. The marker position (abscissa) is defined in the input field *Ref. Marker R*. The marker can be positioned to arbitrary time values. It is switched off in the default setting *(Off)*. The marker level is given by the measurement curve at the marker position.

The position of all markers can be varied using the rotary knob.

Remote control
No command, screen configuration only.

Rel 1

The *Rel. 1* hotkey switches the delta marker 1 on or off (use the *ON/OFF* key).

The delta marker 1 is represented by the symbol 1 in the test diagram. The marker position (abscissa) is defined in the input field *Rel. Marker 1*. The marker can be positioned to arbitrary time values. If its position is outside the diagram area it will be invisible and its coordinates will be "<abscissa_value> / - - -". The marker is switched off in the default setting *(Off)*. The marker level is given by the measurement curve at the marker position.

The toggle switch *Rel 1 Config* pops up when the hotkey is pressed for the second time. It defines whether the position of delta marker 1 is measured and indicated in absolute units (dBm) or relative to the reference marker.

Remote control
No command, screen configuration only.

Rel 2

The *Rel. 2* hotkey switches the delta marker 2 on or off (use the *ON/OFF* key). Functions and remote control are analogous to delta marker 1.

D-Line

The *D-Line* hotkey switches the D-line in the test diagram on or off.

The D-line is a horizontal, colored auxiliary line in the test diagram and is used for marking a level value and for measuring level differences. The level (ordinate) is determined in the input field *D-Line* and indicated on the D-line. The permissible value range is the diagram area, the default setting is Off.

The switch *D-Line Config.* is opened by pressing *D-Line* twice and determines whether the D-line level is expressed in absolute units (in dBm, setting absolute) or relative to the RF Max. Level (in dB, setting relative).

Remote control
No command, screen configuration only.

Display
Marker

The *Display/Marker* softkey zooms or shifts the graphical display. It is selected by pressing the *Marker/Display* softkey twice. If pressed once again, the selected *Display/Marker* softkey changes back to the *Marker/Display* softkey, see above.

Level Scale

The *Level Scale* hotkey defines the level range of the *Power* test diagram (ordinate scale). The scale can be adjusted in 0.1 dB steps. Note that, in contrast to the reference level, the range selection doesn't have any impact on the measurement.

The ordinate scale is calculated from the maximum level defined in the *Connection Control* menu (see section *Analyzer Settings – Table-Oriented Version* on page 4.59) and the range such that

- The *Max Level* defines the upper edge of the diagram.
- The difference *Max Level – Level Scale* defines the lower edge of the diagram.
- The number of horizontal grid lines (corresponding to 10, 15, or 16 cells) and the ordinate labeling is adapted to the range.

Remote control
`[SENSe:]POWer:LEVel:RANGe <Range>`

Time Scale Start

The *Time Scale Start* hotkey defines the left edge of the *Power* test diagram (abscissa scale). The time scale of the diagram is derived from the *Time Scale Start* and the *Time Scale Span* assuming a constant number of 10 horizontal cells:

- *Time Scale Start* defines the left edge of the diagram.
- *Time Scale Start* + *Time Scale Span* defines the right edge of the diagram.
- The abscissa labeling is adapted to the defined time scale.

Time Scale Start is defined relative to the trigger time (delay). The permissible range of start times depends on the span (see below) and on the resolution bandwidth of the power measurement. As a general rule, larger values are allowed if the span is increased and the resolution bandwidth decreased.

Remote control
`[SENSe:]POWer:TIME:DELay <Delay>`

Time Scale Span

The *Time Scale Span* hotkey defines the time range of the *Power* test diagram (abscissa scale). The span is equal to the total measurement range of the *Power* measurement.

The time scale of the diagram is derived from the *Time Scale Start* and the *Time Scale Span* as explained above.

Remote control
`[SENSe:]POWer:TIME:SPAN <Span>`

Menus

The Menus softkey displays the hotkey bar for switching over to the other measurement menus.

Measurement Results

The values represented in the measurement menu *Power* can be divided into three groups:
Setting values

Scalar measurement results (marker values)

The trace plotted as a function of time

These values are indicated in two parameter lines and the test diagram:

Parameter line 1/2

Test diagram with reference marker, delta marker 1 and 2 and D-line.

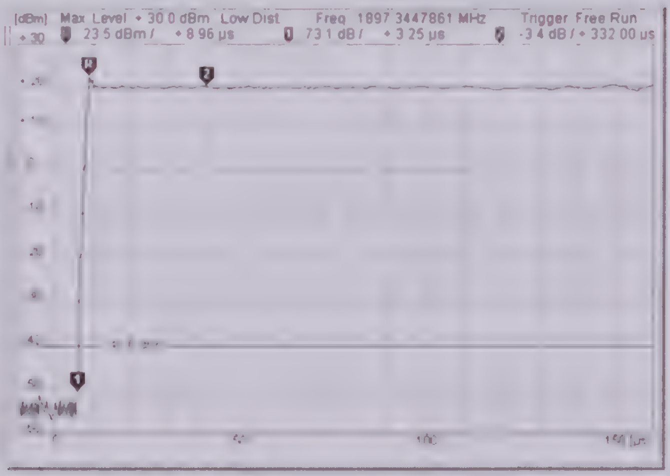

[dBm] Max Level + 30.0 dBm Low Dist Freq 1897.3447861 MHz Trigger Free Run
+30 23.5 dBm / + 8.96 µs 73.1 dB / + 3.25 µs -3.4 dB / + 332.00 µs
R
2
1
150 µs

Fig. 4-22 Display of measurement results (Power menu)

Settings/ scalar measurement results Settings and scalar measurement results are indicated in the two parameter lines above the test diagram

1st parameter line The first parameter line contains the following settings:

RF Max. Level	Maximum value of input level as set in the *Connection Control* menu (see section *Analyzer Settings – Table-Oriented Version* on page 4.59).
RF Attenuation	Setting for the attenuation of the input level *(Normal, Low Noise, Low Distortion)* as set in the *Connection Control* menu (see section *Analyzer Settings – Table-Oriented Version* on page 4.59).
Freq.	Center frequency of the RF signal analyzed
Trigger	Trigger mode *(Free Run, RF Power, IF Power* or *External)*

2nd parameter line The second parameter line contains the following marker values:

R	Level and time of reference marker
1	Level and time of delta marker 1 (setting *absolute*) or difference from reference marker (setting *relative*)
2	Level and time of delta marker 2 (setting *absolute*) or difference from reference marker (setting *relative*)

Remote control Settings are read out using the query corresponding to the setting command (setting command with appended question mark).
To obtain the measurement value at a single point on the trace the whole trace must be read, see below.

Measurement curves (arrays)

The measurement curve is displayed as a continuous trace in the test diagram together with the limit lines, markers and the D-line, if defined.

The measurement curve in the *Power* measurement menu shows the measured power of the received RF signal (in dBm) as a function of time (in µs). The diagram scale, which is equal to the measurement range, and the displayed result depend on the test settings. The display mode for the measurement curve *(Minimum, Maximum, Average, Current)* is indicated in the upper right corner of the diagram.

Remote control

```
READ:ARRay:POWer[:RESult]...?
FETCh:ARRay:POWer[:RESult]...?
SAMPle:ARRay:POWer[:RESult]...?
```

Measurement Configurations (Power Configuration)

The popup menu *Power Configuration* determines the parameters of the power measurement. It is activated by pressing the softkey *Power* in the graphical measurement menu *Power* twice.

The *Power Configuration* menu controls the power measurement. It defines:
The Repetition mode

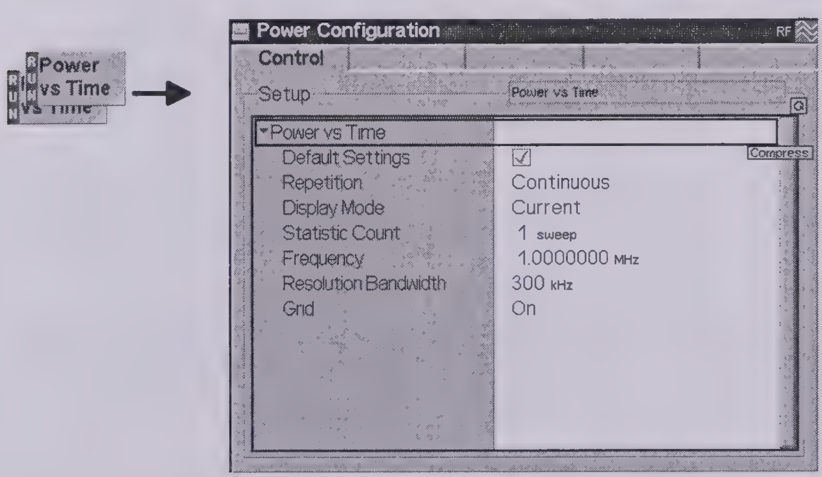
The type of measurement curve to be displayed *(Display Mode)*

The *Statistic Count* for the measurement

The center *Frequency* of the RF analyzer

The *Resolution Bandwidth* of the measurement filter

Besides, it influences the power display by adding or removing the *Grid*.



Setup: Power vs Time

▾Power vs Time

Default Settings	☑
Repetition	Continuous
Display Mode	Current
Statistic Count	1 sweep
Frequency	1.0000000 MHz
Resolution Bandwidth	300 kHz
Grid	On

Fig. 4-23 Power Configuration – Control

Default Settings

The *Default Settings* switch assigns default values to all settings in the *Control* tab (the default values are quoted in the command description in chapter 6 of this manual).

Remote Control

–

Repetition

The *Repetition* field determines the repetition mode. The basic evaluation period (statistics cycle) corresponds to the evaluation of the trace over the entire time range.

For more information see section *Analyzer/Generator Configuration* on p. 4.38 ff. and section *General Settings* in Chapter 3.

Remote control

```
CONFigure:POWer:CONTrol:REPetition
      CONTinuous | SINGleshot | 1 ... 10000,NONE,<Stepmode>
```

Display Mode

The *Display Mode* field defines which of the four measured and calculated measurement curves is displayed. The measurement curves differ in the way the burst power *p(t)* at a fixed point in time *t* is calculated if the measurement extends over several bursts:

Current	Measured value for current burst
Minimum	Minimum over a number of bursts
Maximum	Maximum over a number of bursts
Average	Average value over a number of bursts

The number of bursts for calculation of the statistical values *Minimum, Maximum* and *Average* – and thus the result – depends on the repetition mode set. In detail, this implies:

Single shot	Display of minimum, maximum and average value from the performed statistics cycle.
Continuous	Display of minimum and maximum from all bursts already measured. The **average value**, however, is calculated according to the rule in Chapter 3, section *General Settings*.

Remote control
no display mode set explicitly, the four measurement curves are accessible via

`FETCh:ARRAy:POWer[:CURRent]? FETCh:ARRAy:POWer:MINimum? FETCh:ARRAy:POWer:MAXimum? FETCh:ARRAy:POWer:AVERage?` etc.

Statistic Count

Statistic Count defines how many sweeps are combined to form one statistics cycle. Each sweep corresponds to the evaluation of the trace over the entire time range.

1 to 1000 sweeps	Number of sweeps per statistics cycle

The settings *1* and *OFF* (press *ON/OFF* key) are equivalent. A statistics cycle determines the duration of single-shot measurements (see Chapter 3, section *General Settings*).

Remote control

```
CONFigure:POWer:CONTrol:STATistics  1 ... 1000 | NONE
```

Frequency

Frequency. defines the center input frequency for the measurement in MHz.

Remote control

```
[SENSe:]POWer:FREQuency:CENTer <Frequency>
```

Resolution Bandwidth

Resolution Bandwidth defines the resolution bandwidth of the measurement filter. The nominal resolution bandwidth is the 3-dB bandwidth of the Gaussian measurement filter. From a list discrete bandwidths between 10 Hz and 1 MHz can be selected. The frequencies in the list are given by 1×10^n Hz, 2×10^n Hz, 3×10^n Hz, 5×10^n Hz where n=1 to 5. In addition the value 1 MHz can be selected.

Resolution bandwidths for the analyzer and the *Spectrum* measurement can be set independently (see also p. 4.49).

Remote control

```
[SENSe:]POWer:FREQuency:BANDwidth[:RESolution] <Bandwidth>
[SENSe:]POWer:FREQuency:BWIDth[:RESolution] <Bandwidth>
```

Grid

The *Grid* checkbox switches The grid in the graphical test diagram on or off.

Remote control

–

Spectrum Measurement

The menu group *Spectrum* measures the signal power as a function of the frequency (spectrum analysis). The popup menu *Spectrum Configuration* is used for configuration of the measurements; the results (i.e. the spectrum) are displayed in the graphical measurement menu *Spectrum.*

Measurement Menu (Spectrum)

The graphical measurement menu *Spectrum* displays the results of the spectrum analysis (measurement of signal power as a function of the frequency).

The main softkey *Spectrum* controls the measurement, indicates its status *(RUN | HLT | OFF)* and opens the configuration menu *Spectrum Configuration* (press twice). The hotkey associated to the main softkey defines the scope of the *Spectrum* measurement.

The other softkeys to the right of the test diagram are combined with various hotkeys. If a softkey is selected and an associated hotkey pressed, a popup window will appear which indicates the current setting and enables an entry (see section *Measurement Menu (Power)* on page 4.40).

The measurement menu *Spectrum* is opened from the main menu *Menu Select* (with the associated key at the front of the instrument) or using the *Spectrum* hotkey.

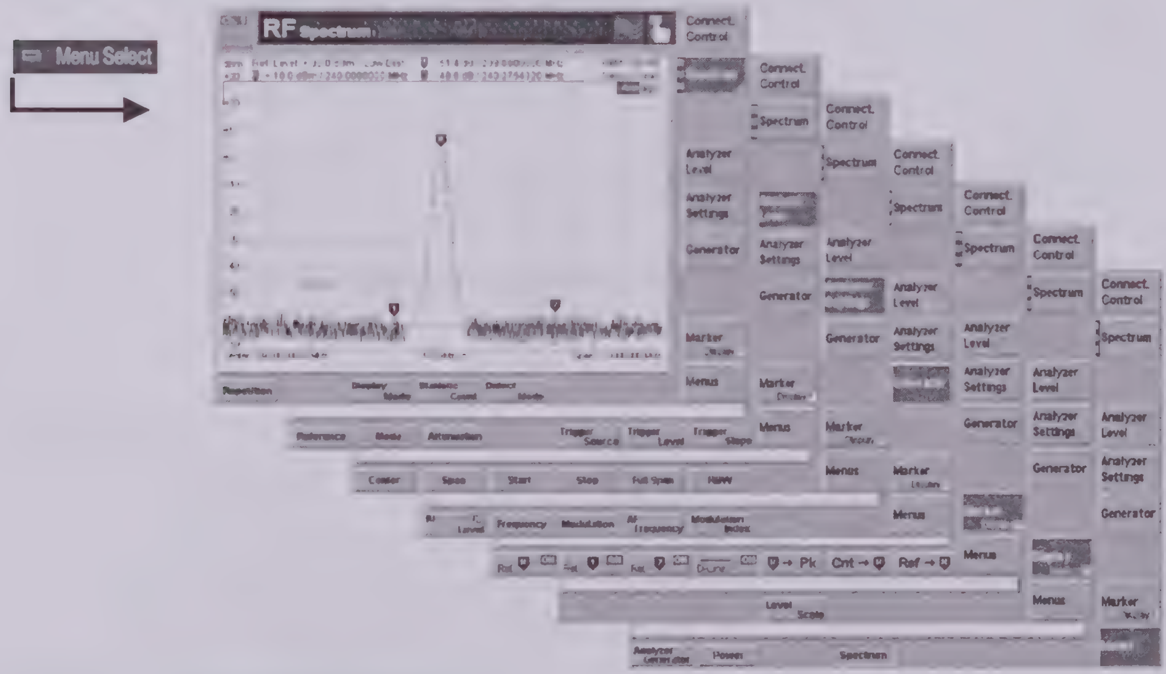

Menu Select
RF Spectrum
Connect Control
Spectrum
Analyzer Level
Analyzer Settings
Generator
Marker
Menus
Repetition
Display Mode
Statistic Count
Detect Mode
Reference
Mode
Attenuation
Trigger Source
Trigger Level
Trigger Slope
Center
Span
Start
Stop
Full Span
RBW
RF Level
Frequency
Modulation
AF Frequency
Modulation Index
→ Pk
Cnt →
Ref →
Level Scale
Analyzer Correction
Power
Spectrum

Fig. 4-24 Measurement menu Spectrum

Test settings

The basic settings for the *Spectrum* measurement are directly accessible from the measurement menu via softkey/hotkey combinations. The entry of values is described in section *Test Settings* on p. 4.35 ff.

Some of the basic settings are also accessible from the *Spectrum Configuration* popup menu. They are explained in more detail in section *Measurement Configurations (Spectrum Configuration)* on page 4.54 ff.

Spectrum

The *Spectrum* softkey controls the spectrum measurement and indicates its status *(RUN | HLT | OFF)*. This status can be changed after softkey selection (pressing once) by means of the *ON/OFF* key or the *CONT/HALT* key.

Remote control

```
INITiate:SPECtrum; ABORt:SPECtrum
STOP:SPECtrum; CONTinue:SPECtrum
FETCh:SPECtrum:STATus?
```

Measurement configuration

Pressing the *Spectrum* softkey twice opens the popup menus *Spectrum Configuration* (see page 4.54 ff). Besides, the measurement control softkey provides hotkeys to define the scope of the measurement. All these settings are described in more detail in section *Measurement Configurations (Spectrum Configuration)* on page 4.54 ff.

Analyzer Level

The *Analyzer Level* softkey controls the level in the RF input signal path and provides the trigger settings for the current measurement.

The input level and trigger settings are general settings and therefore also provided in the *Connection Control* menu. They are described in more detail in sections *Analyzer Settings – Table-Oriented Version* on page 4.59 and *Trigger (Connection Control – Trigger)* on p. 4.72 ff.

Reference Level

The *Reference Level* hotkey defines the reference level.

The reference level defines the upper edge of the diagram. It is generally different from the maximum input level set in the *Connection Control* menu, see section *Analyzer Settings – Table-Oriented Version* on page 4.59.

Remote control

```
[SENSe:]LEVel:REFerence  <LEVel>
```

Analyzer Settings

The *Analyzer Settings* softkey determines the frequency range that is measured and displayed and the resolution bandwidth of the spectrum analyzer.

The settings are specific to the Spectrum menu. Some of them are also provided in the Control tab of the Spectrum Configuration menu; see section *Measurement Configurations (Spectrum Configuration)* on page 4.54 ff.

A single measurement of the signal power over the whole frequency range (span, sweep width) by means of a spectrum analyzer is called a sweep. Typically, the minimum sweep time T_{min} is linked to the resolution bandwidth B of the analyzer and the frequency range F by the relation $T_{min} \sim F/B^2$. This means that a compromise between a high resolution, wide frequency range and high measurement speed must be reached.

The frequency range can be set in three different ways:

- By defining the center frequency f_c and the span Δf. The start and stop frequencies are thus given by $f_{start} = f_c - \Delta f/2$ and $f_{stop} = f_c + \Delta f/2$. This mode is convenient if the spectrum is to be analyzed in the vicinity of a known frequency which can be used as the center frequency of the diagram.
- By defining the start frequency f_{start} and the stop frequency f_{stop}. The center frequency and span are thus given by $f_c = (f_{start} + f_{stop})/2$ and $\Delta f = f_{stop} - f_{start}$.
- By selecting *Full Span* the default frequency range is displayed, i.e. the default start and stop frequencies are selected.

The number of vertical grid lines (i.e. the number of cells in horizontal direction) can be variable (depending on the frequency span) or fixed, see *Spectrum Configuration* menu on page 4.54.

Center

The *Center* hotkey defines the center frequency of the sweep range in MHz or in another frequency unit selected via the unit keys. The center frequency is identical with the *Frequency* set in the *Spectrum Configuration* menu.

Remote control
`[SENSe:]SPECtrum:FREQuency:CENTer <Frequency>`

Span

The *Span* hotkey defines the sweep span.

Remote control
`[SENSe:]SPECtrum:FREQuency:SPAN <Frequency>`

Start

The *Start* hotkey defines the start frequency of the sweep.

Remote control
`[SENSe:]SPECtrum:FREQuency:STARt <Frequency>`

Stop

The *Stop* hotkey defines the stop frequency of the sweep.

Remote control
`[SENSe:]SPECtrum:FREQuency:STOP <Frequency>`

Full Span

The *Full Span* hotkey sets the default sweep span.

On pressing the *Full Span* hotkey the abscissa of the spectrum diagram is changed, and the resolution bandwidth is set to *Auto*. However, the previous scaling parameters and resolution bandwidth are stored and the inscription of the *Full Span* hotkey changes to Last Span. The *Last Span* hotkey allows the previous scaling parameters and resolution bandwidth to be recalled and the previous diagram to be restored.

Remote control
Set *Start* and *Stop* to their default values. Resolution bandwidth see below.

RBW

The *RBW* hotkey defines the resolution bandwidth for the *Spectrum* measurement. The setting is also provided in the *Control* tab of the *Spectrum Configuration* menu; see section *Measurement Configurations (Spectrum Configuration)* on page 4.54 ff.

Remote control
`[SENSe:]SPECtrum:FREQuency:BANDwidth[:RESolution] <Bandwidth>`
`[SENSe:]SPECtrum:FREQuency:BWIDth[:RESolution] <Bandwidth>`

Generator
Tx Aux Tx

The Generator softkey configures the RF signals generated. The generator settings are general settings and therefore also provided in the Connection Control menu. They are described in more detail in section *Generator Settings (Connection Control – Generator)* on p. 4.61 ff.

The RF Level hotkey is also used to switch the RF generator on and off.

If option R&S CMU-B95, *Second RF Generator*, is fitted, the *Generator* softkey toggles between the primary RF signal *(Tx)* and the auxiliary RF signal *(Aux Tx)* settings. The properties of the *Aux Tx* signal are also described in section *Generator Settings (Connection Control – Generator)* on p. 4.61 ff

Marker
Display

The *Marker/Display* softkey positions up to 3 markers and a D-line in the test diagram and displays their values.

If pressed once again, the selected Marker/Display softkey changes to the *Display/Marker* softkey, see below.

Markers	are graphical tools for marking points on the measurement curve and for numerical output of measured values. The measurement menu *Power* provides a reference marker and two further markers which permit to measure differences (delta marker 1 and 2). The coordinates of the three markers are indicated in the format Ordinate value (level)/abscissa value (time) in a parameter line above the test diagram. The position of the reference marker is expressed in absolute units (level in dBm and time in bits), the delta marker by absolute or relative values (relative level in dB or time differences from the reference marker).
D-line	The D-line (display line) is a horizontal line that can be positioned to mark and read out an arbitrary level in the test diagram.

Ref. R

The hotkey *Ref. R* switches the reference marker on or off.

The reference marker is represented by the symbol R in the test diagram. The marker position (abscissa) is determined in the input field *Ref. Marker R*. The marker can be positioned to arbitrary frequency values. If its position is outside the diagram area it will be invisible and its coordinates will be "- - - / <abscissa_value>". The marker is switched off by default. The marker level is given by the trace at the marker position.

The position of all markers can be varied using the rotary knob.

Remote control
No command, screen configuration only

Rel. 1

The *Rel. 1* hotkey switches the delta marker 1 on or off.

The delta marker 1 is represented by the symbol 1 in the test diagram. The marker position (abscissa) is determined in the input field *Rel. Marker 1*. The marker can be positioned to arbitrary frequency values. If its position is outside the diagram area it will be invisible and its coordinates will be "- - - / <abscissa_value>". The marker is switched off by default. The marker level is given by the trace at the marker position.

The toggle switch *Delta Config.1* is opened by pressing *Rel. 1* twice and defines whether the second parameter line shows the absolute position of the delta marker (*absolute*, in dBm and time units) or its distance to the reference marker (*relative*, in dB and time units). If *absolute* is selected the inscription of the *Rel. 1* hotkey changes to *Abs. 1*.

Remote control
No command, screen configuration only

Rel. 2

The *Rel. 2* hotkey switches the delta marker 2 on or off. Its functionality is analogous to delta marker 1.

D-Line

The *D-Line* hotkey switches the D-line in the test diagram on or off.

The D-line is a horizontal, colored auxiliary line in the test diagram and is used for marking a level value and for measuring level differences. The level (ordinate) is determined in the input field *D-Line* and indicated on the D-line. The permissible value range is the diagram area, the default setting is *Off*.

The switch *D-Line Config.* is opened by pressing *D-Line* twice and determines whether the D-line level is expressed in absolute units (in dBm, setting absolute) or relative to the RF Max. Level (in dB, setting relative).

Remote control
No command, only screen configuration

R → Pk

The hotkey *R to Pk* places the reference marker to the maximum of the trace.

Cnt→ R

The hotkey *Cnt to R* centers the diagram to the frequency of the reference marker.

Ref→ R

The hotkey *Ref to R* sets the reference level to the current marker position. It is recommended to use the three softkeys *R to Pk, Cnt to R* and Ref to R in succession to obtain a standard scale for the diagram.

Display Marker

The *Display/Marker* softkey zooms or shifts the graphical display. It is selected by pressing the *Marker/Display* softkey twice. If pressed once again, the selected *Display/Marker* softkey changes back to the *Marker/Display* softkey, see above.

Level Scale

The *Level Scale* hotkey defines the total level range of the *Spectrum* test diagram (ordinate scale). The ordinate scale is calculated from the *Reference* level (see above) and the *Level Scale* such that

- The *Reference* level defines the upper edge of the diagram.
- The difference *Reference* level – *Level Scale* defines the lower edge of the diagram.
- The number of horizontal grid lines (corresponding to 10, 15, or 16 cells) and the ordinate labeling is adapted to the range.

Remote control
`[SENSe:]POWer:LEVel:RANGe <Range>`

Menus

The Menus softkey displays the hotkey bar for switching over to the other measurement menus.

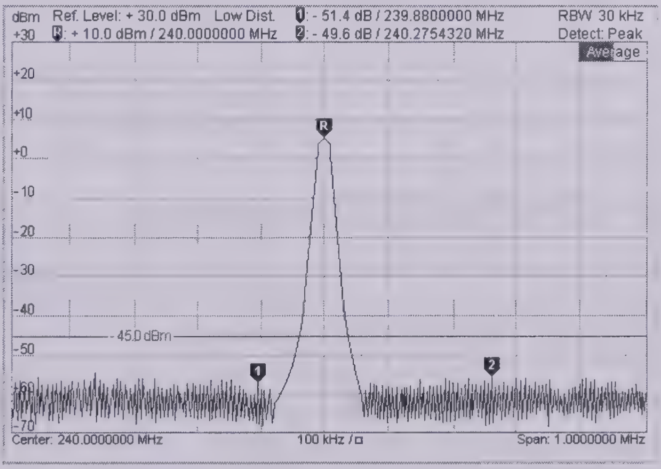
Measurement Results

The values represented in the measurement menu *Spectrum* can be divided into three groups:
Setting values

Scalar measurement results (marker values)

The trace plotted as a function of time

These values are indicated in two parameter lines and the test diagram:


dBm Ref. Level: + 30.0 dBm Low Dist. 1: - 51.4 dB / 239.8800000 MHz RBW 30 kHz
+30 R: + 10.0 dBm / 240.0000000 MHz 2: - 49.6 dB / 240.2754320 MHz Detect: Peak

Parameter line 1/2

Test diagram with reference marker, delta marker 1 and 2 and D-line.

Abscissa labels

Fig. 4-25 Display of measurement results (Spectrum menu)

Settings/ scalar measurement results

Settings and scalar measurement results are indicated in the two parameter lines above the test diagram

1st parameter line

The first parameter line contains the following settings:

Ref. Level	Reference level; upper edge of the diagram as set with the *Analyzer Level – Ref. Level* hotkey
1	Level and time of delta marker 1 (setting *absolute*) or difference from reference marker (setting *relative*)
RBW	Resolution bandwidth *(Auto* or numeric value)

2nd parameter line

The second parameter line contains the following marker values:

R	Level and time of reference marker
2	Level and time of delta marker 2 (setting *absolute*) or difference from reference marker (setting *relative*)

Remote control
Settings are read out using the query corresponding to the setting command (setting command with appended question mark).

To obtain the measurement value at a single point on the trace the whole trace must be read, see below.

Measurement curves (arrays)

The continuous curve in the test diagram shows the measured power (in dBm) as a function of the frequency (in MHz). The curve depends on the display mode *(Current, Max./Min., Average)* that can be set in the configuration menu (see section *Measurement Configurations (Spectrum Configuration)* on page 4.54 ff.). The display mode is indicated in the upper right corner of the diagram.

The measurement curve extends over the frequency range *(Span)* indicated below the diagram and is interpolated from 560 points, each corresponding to one pixel of the CMU's LC display. The number of measurement values is actually larger than 560; the coordinates of the pixels defining the curve can be calculated according to the peak or RMS *Detect Mode* described in section *Measurement Configurations (Spectrum Configuration)* on page 4.54 ff.

Remote control
`READ:ARRay:SPECtrum[:RESult][:CURRent]?`
`FETCh:ARRay:SPECtrum[:RESult][:CURRent]?`
`SAMPle:ARRay:SPECtrum[:RESult][:CURRent]?`
`READ:SUBarrays:SPECtrum[:RESult][:CURRent]?`
`READ:SUBarrays:SPECtrum[:RESult]:AVERage?` etc.

Measurement Configurations (Spectrum Configuration)

The popup menu *Spectrum Configuration* determines statistical and display parameters for the spectrum analysis. It is activated by pressing the softkey *Spectrum* in the graphical measurement menu *Spectrum* twice. In the *Control* tab, the configuration menu defines:
The repetition mode *(Repetition)*

The type of measurement curve to be displayed *(Display Mode)*

The number of sweeps forming a statistics cycle *(Statistic Count)*

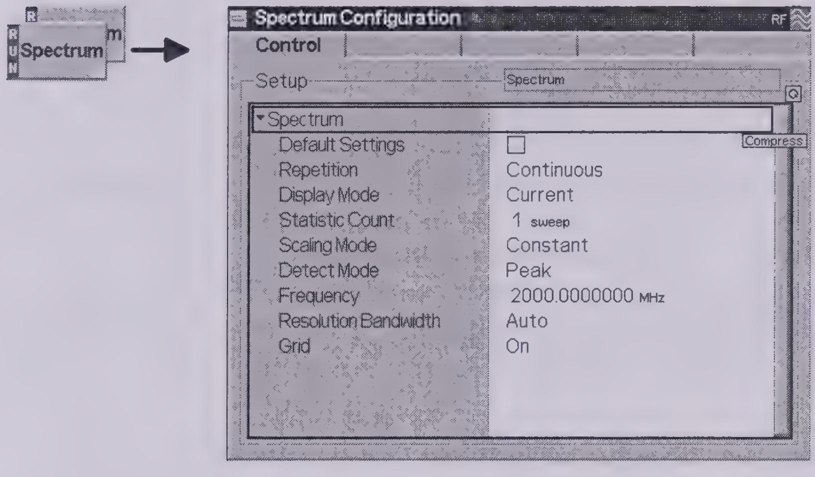
The format of the grid *(Scaling Mode)*

The prescription for calculating the curve from the entire set of measurement points *(Detect Mode)*

The center *Frequency* of the spectrum measurement

The *Resolution Bandwidth* of the measurement filter

Besides, it influences the spectrum display by adding or removing a *Grid* with configurable cells.



Setup: Spectrum

Spectrum	
Default Settings	☐
Repetition	Continuous
Display Mode	Current
Statistic Count	1 sweep
Scaling Mode	Constant
Detect Mode	Peak
Frequency	2000.0000000 MHz
Resolution Bandwidth	Auto
Grid	On

Fig. 4-26 Spectrum Configuration – Control

Many functions of this menu comply with those of the *Control* tab of the *Power Configuration* menu (see page 4.45 f.). In the remote-control commands, the keyword `POWer` is to be replaced by `SPECtrum`.

Default Settings The *Default* switch assigns default values to all settings in the *Control* tab (the default values are quoted in the command description in chapter 6 of this manual).

Remote Control
–

Repetition *Repetition* determines the repetition mode, see chapter 3 and explanations given on page 4.46 for the *Power* measurement.

Remote control
```
CONFigure:SPECtrum:CONTrol:REPetition
      CONTinuous | SINGleshot | 1 ... 10000,NONE,<Stepmode>
```

Display Mode *Display Mode* defines which of the four measured and calculated measurement curves is displayed. The measurement curves differ in the way the RF signal power *p(t)* at a fixed point in time *t* is calculated if the measurement is repeated several times:

Current	Measured value for current sweep
Minimum	Minimum over a number of sweeps
Maximum	Maximum over a number of sweeps
Average	Average value over a number of sweeps

One sweep corresponds to the evaluation of the trace over the whole measurement range. The number of sweeps for calculation of the statistical values *Minimum, Maximum* and *Average* – and thus the result – depends on the repetition mode set (see page 4.46). In detail, this implies:

Single shot	Display of minimum, maximum and average value from the performed statistics cycle (see *Statistic Count* definition below).
Continuous	Display of minimum and maximum from all sweeps already measured. The **average value**, however, is calculated according to the prescription in Chapter 3, section *General Settings*.

Remote control
no display mode set explicitly, the four measurement curves are accessible via

```
FETCh:SUBarrays:SPECtrum[:CURRent]?
FETCh:SUBarrays:SPECtrum:MINimum?
FETCh:SUBarrays:SPECtrum:MAXimum?
FETCh:SUBarrays:SPECtrum:AVERage?
```
etc.

Statistic Count

Statistic Count defines how many sweeps are combined to form one statistics cycle.

1 to 1000 sweeps	Number of sweeps per statistics cycle

The settings *1* and *OFF* (press *ON/OFF* key) are equivalent. A statistics cycle determines the duration of single-shot measurements (see Chapter 3, section *General Settings*).

Remote control
```
CONFigure:POWer:CONTrol  <MODE>,1 ... 1000 | NONE
```

Grid / Scaling Mode

Grid switches on or off the grid in the graphical test diagram. In addition the *Scaling Mode*, i.e. the number of grid cells in horizontal direction (frequency axis) can be selected:

Variable	The number of horizontal grid cells is adapted to the sweep span of the *Spectrum* measurement, see page 4.50,
Constant	The diagram consists of a constant number of 10 horizontal grid cells.

Remote control
```
DISPlay:SPECtrum:CONTrol:GRID  ON | OFF
```

Detect Mode

Detect Mode defines how the measurement curve is calculated from the entire set of measurement points. The curve is interpolated from 560 points, each corresponding to one pixel of the CMU's LC display. The number of measurement values is actually larger than 560; the coordinates of the pixels defining the curve can be calculated in two alternative ways:

Peak	The y-coordinate (power) of each pixel is equal to the maximum of all measurement values falling inside the pixel range.
RMS	The y-coordinate of each pixel is equal to the RMS average of all measurement values falling inside the pixel range.

The two settings yield different curves, especially in domains where the signal shows strong power variations (e.g. in the noise floor around a distinct spectral lobe). RMS averaging tends to smooth out the spectral curve and to suppress the noise. On the other hand, very narrow peaks may be underestimated if RMS *Detect Mode* is set.

Remote control
```
[SENSe:]SPECtrum:DETector  PEAK | RMS
```

Frequency

Frequency defines the center frequency of the measurement range in MHz or in another frequency unit selected via the unit keys. The center frequency is identical with the *Center* frequency set with the *Analyzer Settings* softkey.

Remote control
```
[SENSe:]SPECtrum:FREQuency:CENTer <Frequency>
```

Resolution Bandwidth

Resolution Bandwidth defines the resolution bandwidth for the *Spectrum* measurement. The resolution bandwidth is identical with the *RBW* set with the *Analyzer Settings* softkey.

The nominal resolution bandwidth is the 3-dB bandwidth of the measurement filter. From a list discrete bandwidths between 10 Hz and 1 MHz can be selected. The frequencies in the list are given by 1×10^n Hz, 2×10^n Hz, 3×10^n Hz, 5×10^n Hz where n=1 to 5. In addition the two values 1 MHz and *Auto* can be selected.

With the *Auto* setting the resolution bandwidth is automatically adapted to

bandwidth = span/50

(if this value is inside the allowed range).

Resolution bandwidths for the analyzer and the *Power* measurement can be set independently (see also p.SEITENREFFORMATVERBINDEN 4.40).

Remote control

```
[SENSe:]SPECtrum:FREQuency:BANDwidth[:RESolution] <Bandwidth>
[SENSe:]SPECtrum:FREQuency:BWIDth[:RESolution] <Bandwidth>
```

Connection Control

The popup menu *Connection Control* contains several tabs to configure the inputs and outputs of the CMU and the respective signals in the *RF* function group and the trigger settings.

The menu group is activated via the softkey *Connect. Control* to the right of the header of each measurement menu. The individual tabs *(Analyzer. Generator, RF ··, Sync., Trigger, I/Q-IF)* can be accessed via the hotkey bar at the lower edge of the screen.

Analyzer Settings (Connection Control – Analyzer)

The *Analyzer* tab adjusts the RF input path to the expected input power *(RF Max. Level)* and sets the center frequency of the RF analyzer. The CMU provides a softkey-oriented version of the *Analyzer* tab and a table-oriented version with extended functionality. The *Analyzer* hotkey toggles between the two versions if it is pressed repeatedly.

Softkey-Oriented Version

The softkey-oriented version of the *Analyzer* tab determines the maximum input level *(RF Max. Level)*, the way this level is defined *(RF Mode)* and the attenuation of the RF input path *(RF Atten.)*. All settings of this menu are also provided in the table-oriented version of the *Analyzer* tab; see section *Table-Oriented Version* on p. 4.59 ff.

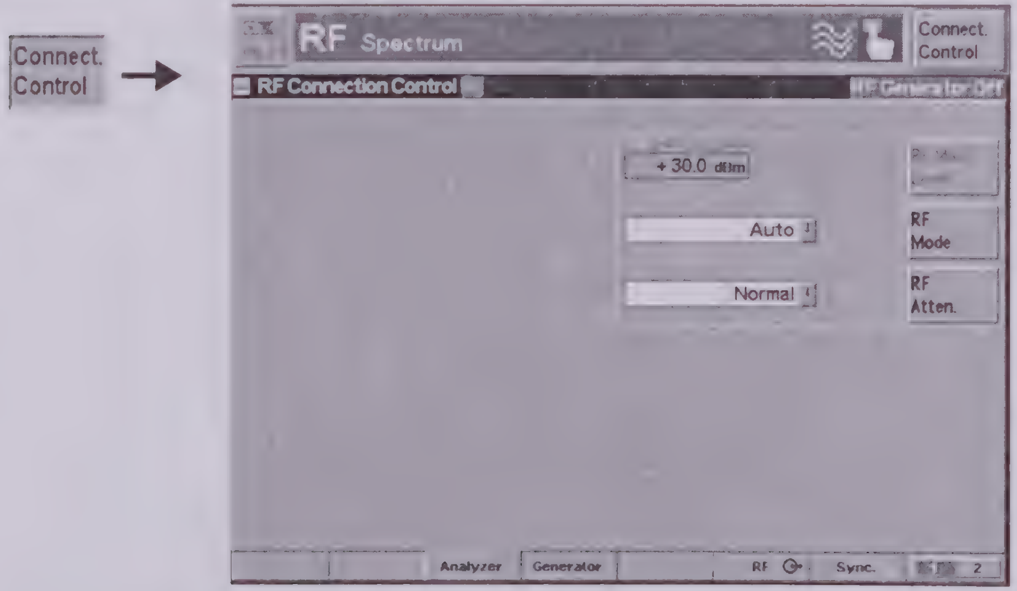


Fig. 4-27 Connection Control – RF analyzer settings (softkey)

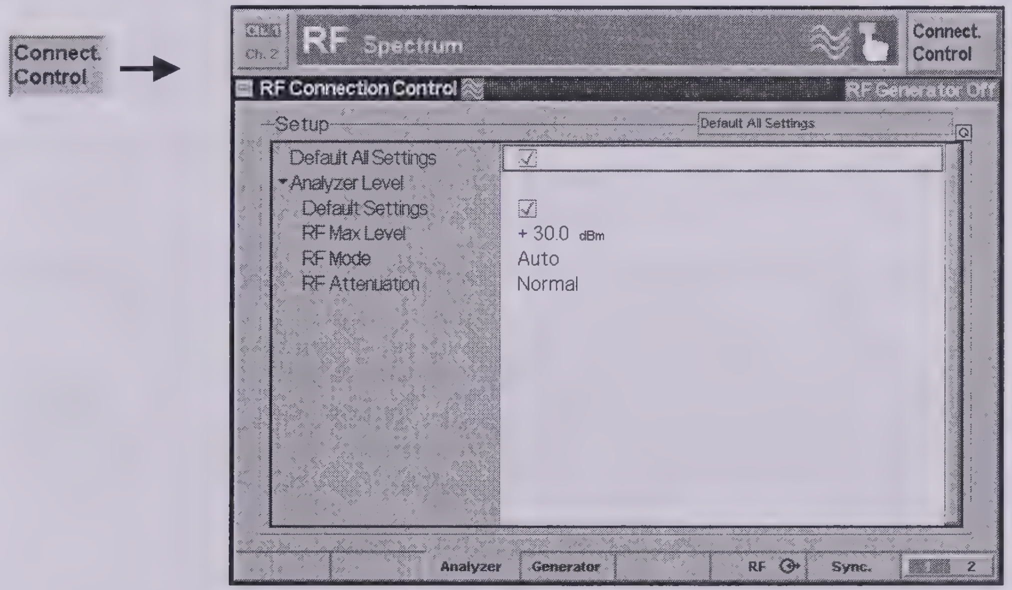
Table-Oriented Version

The table-oriented version of the *Analyzer* tab determines:
The maximum expected input level *(RF Max. Level)* and the way it is defined *(RF Mode)*

An external input attenuation or gain *(RF Attenuation)*

The *Frequency* and the resolution *Bandwidth* of the RF analyzer *(Analyzer Settings)*

The *RF Path* for the analyzed signal



Default All Settings ☑
Analyzer Level
Default Settings ☑
RF Max Level + 30.0 dBm
RF Mode Auto
RF Attenuation Normal

Fig. 4-28 Connection Control – RF analyzer settings (table)

Default Settings *Default All Settings* assigns default values to all settings in the *Analyzer* tab (the default values are quoted in the command description in chapter 6 of this manual). Additional default switches are provided for the *Analyzer Level* and *Analyzer Settings* table sections.

Remote Control
`[SENSe:]LEVel:DEFault`

RF Max. Level *RF Max. Level* determines the maximum permissible input level (overload level). The maximum input level determines the upper edge of the diagram in the graphical menu *Power* and is also displayed next to the softkey *RF Max. Level* in the main menu *Analyzer/Generator* (see page 4.33). The upper edge of the *Spectrum* diagram is set independently via the *Reference* hotkey, see section *Test settings* on page 4.49.

RF Mode *RF Mode* determines how the maximum input level is set:

Manual	Manual input of maximum input level
Auto	Automatic setting of maximum input level (autoranging) according to the power of the applied signal.

Remote control
`[SENSe:]LEVel:MODE MANual | AUTomatic`

The value range depends on the selected RF input (see section *Generator Settings (Connection Control – Generator)* on page 4.61):

External attenuation

If an external input attenuation is reported to the instrument (see section *RF Connectors (Connection Control – RF)* on page 4.65), all levels measured are referenced to the output of the DUT and therefore shifted with respect to the actual level at the input connectors of the CMU. The level ranges for the input connectors are shifted as well.

Input levels exceeding the *RF Max. Level* can not be measured; the corresponding measurement result fields indicate invalid results "– – –".

Error messages

If the value determined for *RF Max. Level* is too high or too low, a window with the error message *"<Max_Level> is out of range. <permissible max. value> is limit."* and three fields will appear:

Accept	The permissible max. value is accepted as RF Max. Level
Re-edit	RF Max. Level is entered once again
Cancel	The last valid input value is maintained

When switching over to another input, the current value of *RF Max. Level* is automatically adapted, if required:

- Towards lower values to the maximum permissible value of the new input,
- Towards upper values to the minimum value of the new input.

Note: *A maximum input level can be entered even if automatic level setting (autoranging) is selected. The entered level is used as a start value for the autoranging routine and is also important to ensure safe switchover to manual setting.*

Remote control
`[SENSe:]LEVel:MAXimum <Level>`

RF Attenuation

*RF Attenuation*defines how the RF analyzer of the CMU is tuned to meet the requirements of the current measurement type. In general, a compromise between the acceptable noise level in the displayed result and the contribution of internally generated distortion must be reached.

Normal	Mixer level in normal range
Low noise	Mixer level enhanced by +10 dB (full dynamic range of CMU, therefore recommended for both *Power* and *Spectrum* measurements)
Low distortion	Mixer level reduced by –10 dB (high intermodulation spacing)

The *RF Attenuation* setting permits the CMU to be adapted to the requirements of the measurement. The advantages and disadvantages of the settings *Low noise* and *Low distortion* are listed in the following table.

	Advantages	**Disadvantages**
Low noise	Low noise high dynamic range	No RF overdrive reserve Risk of intermodulation
Low distortion	High intermodulation spacing	Lower dynamic range

Remote control
`[SENSe:]LEVel:ATTenuation  NORMal | LNOise | LDIStortion`

Generator Settings (Connection Control – Generator)

The *Generator* tab configures the RF generator, in particular by defining the output level *(RF Level)*, the *Frequency*, *Modulation*, and *Frequency Hopping.* The CMU provides a softkey-oriented version of the *Generator* tab and a table-oriented version with extended functionality. The *Generator* hotkey toggles between the two versions if it is pressed repeatedly.

Softkey-Oriented Version

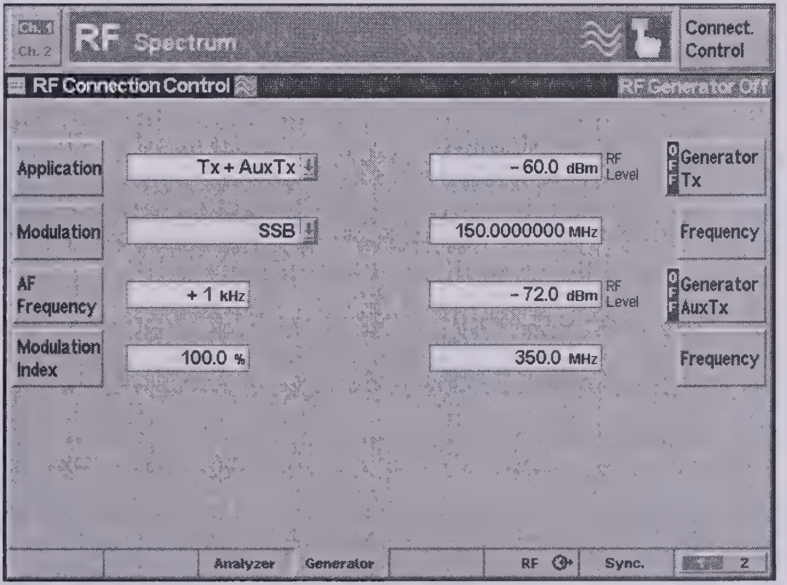
The *Generator* tab controls and configures the RF generator. The CMU provides two independent RF signals *Tx* and *Aux Tx* (with option CMU-B95, *Additional RF Generator)*, which can be configured as follows:

Level and frequency settings *(RF Level, Frequency)*

Selection of an offset frequency or amplitude modulation *(Modulation, SSB Frequency, Modulation Index)*

All settings of this menu are also provided in the softkey-oriented version of the *Generator* tab; see section *Table Oriented Version* on p. 4.61 ff.

Connect. Control →



Application: Tx + AuxTx

Modulation: SSB

AF Frequency: + 1 kHz

Modulation Index: 100.0 %

RF Level: - 60.0 dBm (Generator Tx: OFF)

Frequency: 150.0000000 MHz

RF Level: - 72.0 dBm (Generator AuxTx: OFF)

Frequency: 350.0 MHz

Fig. 4-29 Connection Control – RF generator settings (softkey)

Table Oriented Version

The table-oriented version of the *Generator* tab configures the two independent sine wave signals *Tx* and *Aux Tx*: It defines:

Level, Frequency and *Modulation* of the signals

Switchover between two frequencies *(Frequency Hopping,* for Tx signal only)

Time dependence of the signal power *(Ramping,* for Tx signal only)

Aux Tx signal:

If option CMU-B95, *Additional RF Generator*, is fitted, the CMU provides a second RF signal AuxTx that can be applied to one of the RF connectors RF1 or RF2. It is possible to superimpose both RF signals at the same output connector or use different connectors (see section *RF Connectors (Connection Control – RF)* on p. 4.65 ff.). Moreover, it is possible to assign independent external attenuation factors to both signals.

AuxTx is generated with the modulation settings of the primary Tx signal (`...:RFGenerator:MODulation...`) but with no frequency hopping or ramping. Option CMU-B95 extends the functionality of the GSM-MS measurements, see operating manual for options R&S CMU-K20/…/K24.

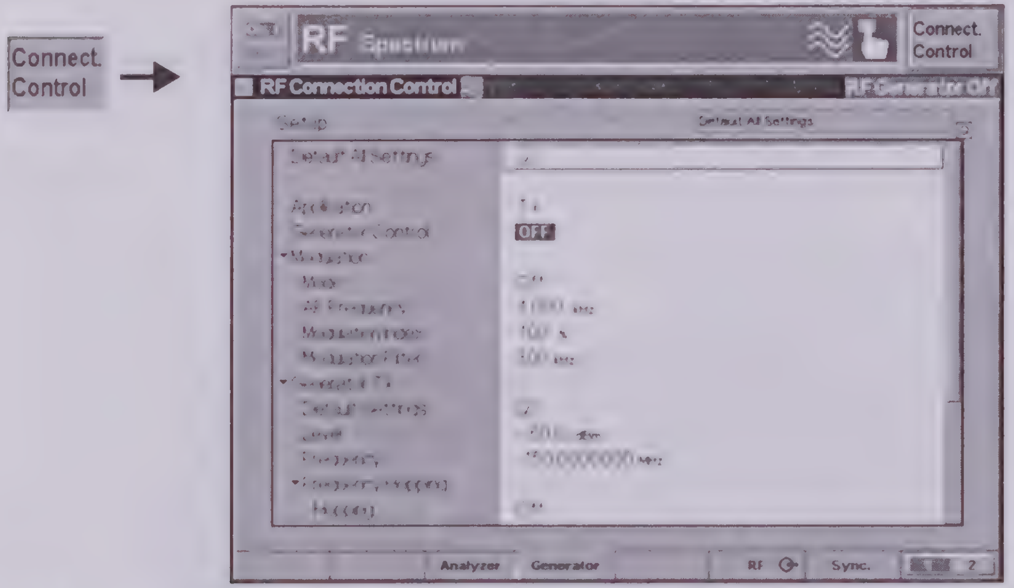


Fig. 4-30 Connection Control – RF generator settings (table)

Default Settings *Default All Settings* assigns default values to all settings in the *Generator* tab (the default values are quoted in the command description in chapter 6 of this manual). Additional default switches are provided for the individual signals *Tx* and *Aux Tx*.

Remote Control
`DEFault:RFGenerator`

Application *Application* selects one of the following RF generator signal configurations:

Tx	The primary RF signal *Tx* is generated according to the settings in the *Generator* tab. The additional signal *Aux Tx* is always switched off.
Aux Tx	The additional signal *Aux Tx* is generated according to the settings in the *Generator* tab. The primary signal *Tx* is always switched off.
Tx + Aux Tx	Both the primary signal *Tx* and the additional signal *Aux Tx* can be generated.

Selecting an application does not automatically switch on the RF generator; see *Generator Control* below.

Remote Control
`CONFigure:RFGenerator:APPLication RX | AUXT | TXAT`

Generator Control

Generator Control controls the RF generator and indicates its operating state *(ON | OFF)*.

This function depends on the selected *Application* (see above):

In the default setting *(Application = Tx), Generator Control* switches the primary signal *Tx* on or off. All *Aux Tx* generator settings are ignored.

If the additional signal *Aux Tx* is selected *(Application = Aux Tx), Generator Control* switches the additional signal *Aux Tx* on or off. All *Tx* generator settings are ignored.

If both signals are selected *(Application = Tx + Aux Tx), Generator Control* switches both signals on or off.

Remote Control

```
INITiate:RFGenerator
ABORt:RFGenerator
FETCh:RFGenerator:STATus?
```

The following modulation settings are valid for both the *Tx* and the *Aux Tx* signal.

Modulation – Mode

Modulation – Mode selects the modulation scheme of the RF signal.

OFF	Unmodulated (CW) RF carrier signal
SSB	RF carrier is shifted by a constant AF offset frequency defined with the AF Frequency softkey (Single Side Band modulation).
AM	RF carrier is amplitude-modulated by means of AF signal with constant frequency and modulation index set with the AF Frequency and Modulation Index softkeys.

Note: *The AM setting shifts the level ranges of all three RF outputs by –6 dB.*

Remote control

```
SOURce:RFGenerator:MODulation OFF | SSB | AM
```

AF Frequency

AF Frequency defines an AF frequency which is used for SSB or AM modulation; see Modulation softkey above.

If SSB modulation is set, the frequency of the RF carrier signal is shifted by the AF frequency, which can be either positive or negative. If AM modulation is set, the RF signal is amplitude-modulated with the AF frequency (which has to be positive) and with a given modulation index (see softkey *Modulation Index* below). An application for SSB modulation is given in chapter 7.

Remote control

```
SOURce:RFGenerator:MODulation:SSB:FREQuency <Frequency>
```

Modulation Index

Modulation Index defines the modulation index for AM modulation, i.e. the amplitude ratio of the modulating AM signal to the RF carrier signal in percent.

The modulation index is in the range of 0% (no amplitude modulation) to 100%. Overmodulation is excluded.

Remote control

```
SOURce:RFGenerator:MODulation:AM:INDex <Mod_Index>
```

Modulation Filter

Modulation Filter defines the resolution bandwidth of the modulation filter. The bandwidths 30 kHz, 300 kHz or *Off* (corresponding to a broadband modulation filter) can be selected.

In a *Spectrum* measurement a modulation filter suppresses the signals located to the right and to the left of the center frequency.

Remote control

`SOURce:RFGenerator:BANDwidth[:RESolution] <Bandwidth>`

The following settings are provided separately for the *Tx* and for the *Aux Tx* signal.

Level

Level defines the total level of the generated RF signals in dBm. The value range depends on the selected RF output (RF 1, RF 2 or RF 3 OUT).

External attenuation

If an external gain or attenuation is used and reported to the instrument (see softkey *Ext. Att. Output* in the menu *RF* ··· on page 4.65) the RF generator level is adjusted to maintain the commanded power after the attenuation or gain. As a consequence, all levels indicated are referenced to the input of the DUT and no longer correspond to the actual level at the output connectors of the CMU. The default value for the generator power is also shifted provided that the generator can output the required power, compensating for the external attenuation or gain. Otherwise it is adapted to the level closest to the shifted default value.

Error messages

If the entered generator level is too high or too low, a window with the error message *"<Max_Level> is out of range. <permissible max. value> is limit."* and three fields will appear:

Accept	The permissible max. value is accepted as RF Level,
Re-edit	RF Level is entered once again,
Cancel	The last valid input value is maintained.

When switching over to another output, the current value of RF Level is automatically adapted, if required:

- Towards lower values to the maximum permissible value of the new output,
- Towards upper values to the minimum value of the new output.

Remote control

```
SOURce:RFGenerator:LEVel <Level>
SOURce:RFGenerator:AUXTx:LEVel <Level>
```

Frequency

Frequency defines the frequency of the generated RF signals.

Remote control

```
SOURCe:RFGenerator:FREQuency <Frequency>
SOURCe:RFGenerator:AUXTx:FREQuency <Frequency>
```

The following settings are provided for the *Tx* signal only.

Frequency Hopping

Frequency Hopping defines whether *Tx* is a signal with a single, constant basic frequency (frequency hopping *Off*) or a signal with two alternating frequencies (frequency hopping *On)* .

The basic frequency is the *Frequency* set in the *RF Analyzer/Generator* menu. The second (hopping) frequency can be entered in the *Hopping Frequency* input field. Two definitions of the hopping frequency are provided:

Absolute	The absolute value of the hopping frequency is entered.
Relative	The difference between the hopping frequency and the basic frequency is entered. The resulting absolute frequency, i.e. $f_{abs} = f_{rel} + f_{base}$ must lie in the allowed range for the CMU (see data sheet).

If frequency hopping is selected the RF signal frequency changes after every 4.615 ms: the dwell time at a frequency is as for GSM signals.

Remote control

```
SOURce:RFGenerator:FHOPping:STATe <ON | OFF>
SOURce:RFGenerator:FHOPping:FREQuency <Frequency>
SOURce:RFGenerator:FHOPping:FREQuency:MODE
                                        <ABSolute | RELative>
```

Ramping

The *Ramping* parameter defines whether the *Tx* is a continuous, unmodulated signal (CW signal, Ramping is *Off)* or a series of pulses (Ramping is *On)*.

If ramping is *On* the CMU generates rectangular, GSM-like pulses with a duration of 577 µs.

Remote control

```
SOURce:RFGenerator:PULSe:STATe <ON | OFF>
```

RF Connectors (Connection Control – RF)

The tab *RF* ↔ configures the connectors for the two RF signals *Tx* and *Aux Tx* (with option CMU-B95, *Additional RF Generator;* see section *Generator Settings (Connection Control – Generator)* on p. 4.61 ff.). This includes:
Selection of the RF signal *(TX / Aux Tx)*

The RF input and output of the CMU *(RF Output, RF Input)*

An external attenuation at the connectors *(Ext. Att. Output, Ext. Att. Input)*

Besides, the tab controls the *Wideband* power meter and displays the result.

Connect. Control →

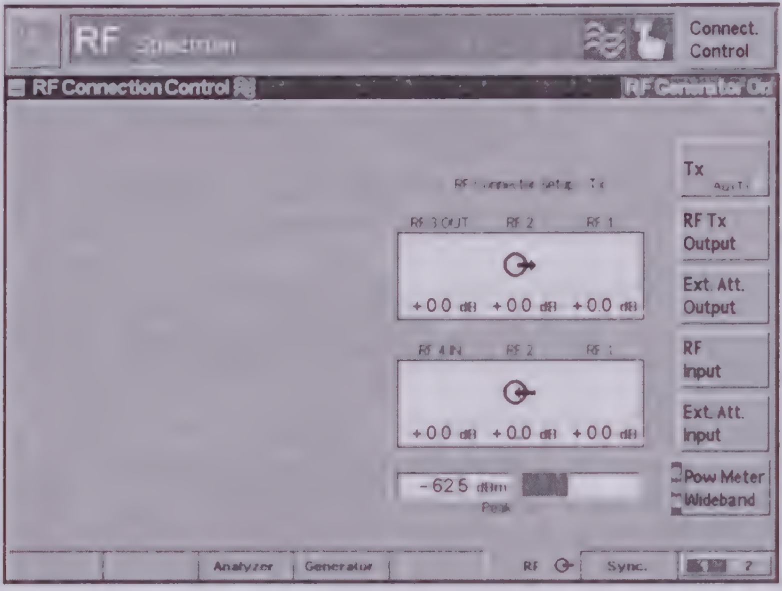

RF Spectrum
Connect. Control
RF Connection Control
RF Generator On
RF connector setup: Tx
RF 3 OUT
RF 2
RF 1
+0.0 dB
+0.0 dB
+0.0 dB
RF 4 IN
RF 2
RF 1
+0.0 dB
+0.0 dB
+0.0 dB
-62.5 dBm
Peak
Tx
Aux Tx
RF Tx Output
Ext. Att. Output
RF Input
Ext. Att. Input
Pow Meter Wideband
Analyzer
Generator
RF
Sync.
?

Fig. 4-31 Connection Control – RF connectors

Tx Aux Tx

Tx / Aux Tx toggles between the primary RF signal *Tx* and the additional signal *Aux Tx*, to be routed to one of the RF output connectors of the instrument.

The two RF signals are independent from each other. It is possible to route the signals to different RF output connectors or superimpose them at the same connector. If *Aux Tx* is selected, *RF Tx Output* changes to *RF Aux Tx Output*, and the input softkeys are hidden.

Remote control
`OUTPut[:STATe] RF1 | RF2 | RF3`

RF Tx Output

The RF Tx Output softkey defines which of the three connectors RF 1, RF 2 and RF 3 OUT is to be used as RF output connector for the *Tx* signal. The selected RF output is indicated by a ⟴ symbol.

If the additional RF signal *Aux Tx* is selected (see above), the softkey is labeled *RF Aux Tx Output* and selects the output connector for *AuxTx*.

Note: *Input and output connectors can be combined at will. The bidirectional connectors RF 1 and RF 2 can be selected as RF inputs and outputs at the same time.*

The LEDs on the front panel are only „on“ (light) if the output level is switched on.

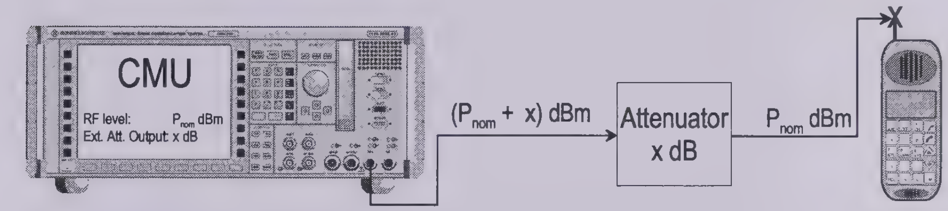
Remote control
```
OUTPut[:TX][:STATe] RF1 | RF2 | RF3
OUTPut:AUXTx[:STATe] RF1 | RF2
```

Ext. Att. Output

The softkey *Ext. Att. Output* defines an external attenuation (or gain, if the value is negative) at the selected RF output.

Input of an external attenuation is suitable if, e.g., a path attenuation (cable) is included in the test setup, which is to be compensated for by an increased signal level.

If an external attenuation is defined, the output signal level is referenced to the input of the DUT, the generator level is therefore shifted with respect to the actual level at the input connector of the CMU. The default value for the generator power and the level ranges for the RF outputs are also shifted provided that the generator can output the required power, compensating for the external attenuation or gain. Otherwise it is adapted to the level closest to the shifted default value.



Note: RF User Correction

> *In addition to the static external output attenuation setting, the CMU provides a systematic correction of the generated RF power by means of user-defined, frequency and level-dependent correction tables; see section* RF User Correction *in Chapter 1.*

Remote control

```
[SENSe:]CORRection:LOSS:OUTPut<nr>[:TX][:MAGNitude] <Loss>
SOURce:CORRection:LOSS:OUTPut<nr>[:TX][:MAGNitude] <Loss>
[SENSe:]CORRection:LOSS:OUTPut<nr>:AUXTx[:MAGNitude] <Loss>
SOURce:CORRection:LOSS:OUTPut<nr>:AUXTx[:MAGNitude] <Loss>
```

RF Input

The RF Input softkey determines which of the three connectors RF 1, RF 2 and RF 4 IN is to be used as RF input connector. The selected RF output is indicated by a ⊖ symbol. Input and output connectors can be arbitrarily combined.

Remote control

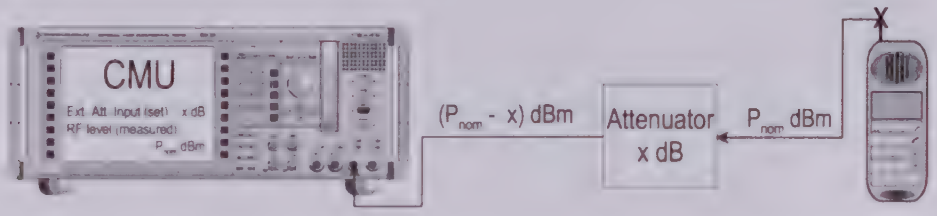
```
INPut[:STATe] RF1 | RF2 | RF4
```

Ext. Att. Input

The softkey Ext. Att. Input enters the value of the external attenuation (or gain) at the selected RF input.

Input of an external attenuation is required if, for example, external attenuator pads are used for protection of the sensitive RF inputs of the CMU or if a path attenuation is included in the test setup.

If an external input attenuation is reported to the instrument, all levels measured are referenced to the output of the DUT and therefore shifted with respect to the actual level at the input connectors of the CMU. The level ranges for the input connectors are shifted as well.



Note: *The LEDs on the front panel are only "on" (light) if the measurement is active.*

Note: RF User Correction

In addition to the static external input attenuation setting, the CMU provides a systematic correction of the measured RF power by means of user-defined, frequency and level-dependent correction tables; see section RF User Correction in Chapter 1.

Remote control

```
[SENSe:]CORRection:LOSS:INPut<nr>[:MAGNitude]
SOURce:CORRection:LOSS:INPut<nr>[:MAGNitude] <Loss>
```

Pow. Meter Wideband

The *Pow. Meter Wideband* softkey controls the wideband power measurement and indicates its status *(RUN | HLT | OFF)*. The status can be changed after softkey selection (pressing once) by means of the *ON/OFF* key or the *CONT/HALT* key. The measurement result is in units of dBm. The analog bar to the right of the softkey shows the measured power relative to the total measurement range (see Chapter 6).

The wideband power measurement is performed at the RF Frontend of the CMU and yields the peak power of the input signal inside a wide frequency range. For modulated RF signals, the result of the wideband power measurement depends on the modulation characteristics. The main purpose of the wideband power measurement is to indicate whether an input signal is available and whether it is advisable to change the *Max Level* settings.

Note: *The RF function group provides a wide selection of power measurements. For an overview see section Analyzer/Generator on p. 4.33 ff.*

Remote control

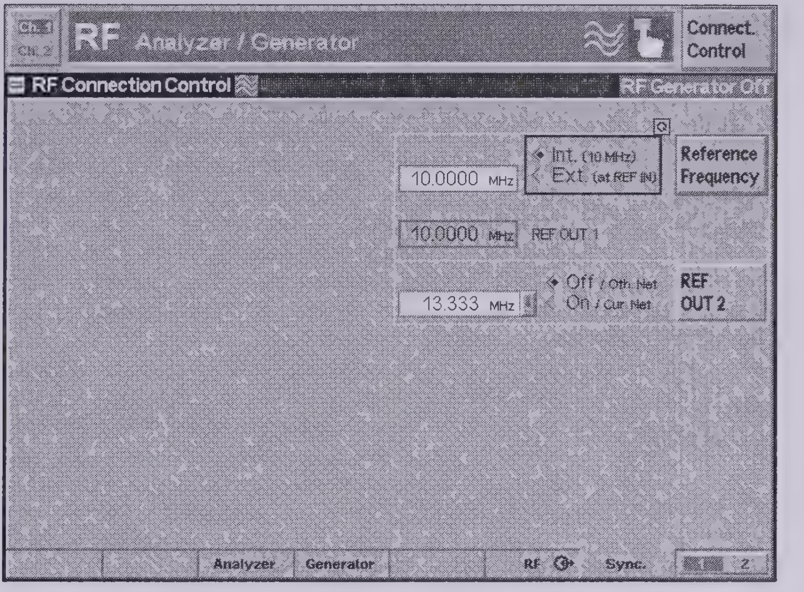
```
INITiate:WPOWer
FETCh:WPOWer:STATus?
READ[:SCALar]:WPOWer?
FETCh[:SCALar]:WPOWer?
SAMPle[:SCALar]:WPOWer?
```

Reference Frequency (Connection Control – Synch.)

The tab *Synch.* determines the reference signals for synchronization. This includes
The internal or external *Reference Frequency*

The output mode for the network-specific system clock *(REF OUT 2)*.

Connect. Control →


Ch. 1
Ch. 2
RF Analyzer / Generator
Connect. Control
RF Connection Control
RF Generator Off
Reference Frequency
REF OUT 2
Analyzer
Generator
RF
Sync.
2

10.0000 MHz ◆ Int. (10 MHz) ◇ Ext. (at REF IN)

10.0000 MHz REF OUT 1

13.333 MHz ◆ Off / Oth. Net ◇ On / Cur. Net

Fig. 4-32 Connection Control – Synchronization

Reference Frequency

The *Reference Frequency* softkey determines the source and the frequency of the reference signal.

The associated field allows to select between two alternatives:

Int. (10 MHz)	Internal synchronization by means of a 10 MHz reference frequency (TCXO or OCXO, CMU-B11/-B12).
Ext. (at REF IN)	Synchronization to external reference signal to be fed in via input REF IN. The external reference signal can be used for synchronization of the CMU to another instrument. Its frequency must be entered in the input field next to the *External* button.

The reference signal used is also routed to output *REF OUT 1* so that it can be fed to other instruments as well.

Note:

The header cyclically displays a warning if no synchronization could be achieved e.g. because of missing or faulty input signal with external synchronization selected. At the same time, bit no. 6 (RFNL, Reference Frequency Not Locked) is set in the STATus:OPERation:CMU:SUM1:CMU1 sub-register associated to the CMU base system and the query `[SENSe:]SYNChronize:FREQuency:REFerence:LOCKed?` *returns the value* `ON`.

In the case of external synchronization with squarewave signals (TTL) ensure correct signal matching to avoid reflections. Otherwise, resulting overshoots may cause trigger problems at the CMU input. A possible remedy is to use a lowpass filter or an attenuator pad directly at the CMU input. Correct synchronization may be checked by comparing the signal REF OUT 1 with the input signal.

This configuration is valid in all CMU function groups.

Caution: *The reference frequency is set to Int. (10 MHz) whenever the base system is reset. After switching back to Ext. (at REF IN) it is necessary to allow for a setting time (~1 s) before the CMU can synchronize to the external reference frequency. The delay is avoided by a partial reset of all function groups with the exception of the base system.*

Remote control
The commands for the reference frequency are part of the CMU base system:

```
CONFigure:SYNChronize:FREQuency:REFerence:MODE
      INTernal | EXTernal
CONFigure:SYNChronize:FREQuency:REFerence <Frequency>
[SENSe:]SYNChronize:FREQuency:REFerence:LOCKed?
```

REF OUT 2

The softkey REF OUT 2 configures a network-specific system clock REF OUT 2 to be fed to the output REF OUT 2 at the rear of the instrument. The clock frequency can be used to synchronize other instruments to the CMU.

The associated field permits to select between two alternatives:

OFF (other network)	The clock frequency of the current function group is not fed to the output REF OUT 2. With this setting the system clock of another active function group (e.g. the network GSM1800 while the current network is GSM900) is still applied to REF OUT 2 provided that the output REF OUT 2 is switched on in the other function group. However, if REF OUT 2 is explicitly switched over from On to Off the clock signal is definitely removed.
On (current network)	The network-specific system clock of the current function group is fed to output REF OUT 2. The system clock of any other function group applied to REF OUT 2 before is replaced.

Besides the basic clock frequency of 40 MHz one of the following clock frequencies may be selected:

40.000 MHz, 20,000 MHz, 13.334 MHz, 10.000 MHz, 8.000 MHz, 6.667 MHz, 5.715 MHz,
5.000 MHz, 4.445 MHz, 4.000 MHz, 3.637 MHz, 3.334 MHz, 3.077 MHz, 2.858 MHz,
2.667 MHz, 2.500 MHz, 2.353 MHz, 2.223 MHz, 2.106 MHz, 2.000 MHz, 1.905 MHz,
1.819 MHz, 1.740 MHz, 1.667 MHz, 1.600 MHz, 1.539 MHz, 1.482 MHz, 1.429 MHz,
1.380 MHz, 1.334 MHz, 1.291 MHz, 1.250 MHz

(The values are calculated according to the formula $F_{out\,0}= 40.000\ MHz / n$ where $n = 1, ..., 32$.)

Remote control

```
SOURce:DM:CLOCk:STATe ON | OFF
SOURce:DM:CLOCk:FREQuency <Frequency>
```

Trigger (Connection Control – Trigger)

The *Trigger* tab is part of the second group of tabs in the *Connection Control* menu. It is accessible after pressing the *1 / 2* toggle hotkey once. Pressing *1 / 2* again switches back to the first group of tabs described above.

The *Trigger* tab defines the trigger condition for the measurement and the input for the external trigger signal.

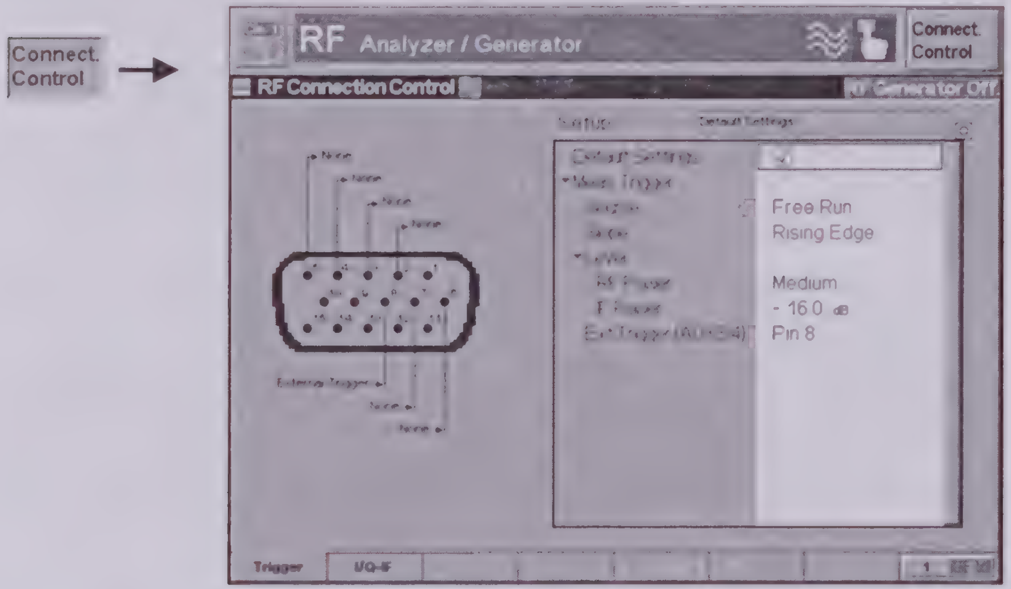


Fig. 4-1 Connection Control – Trigger

Default Settings The *Default Settings* checkbox assigns the default setting to all functions in the *Trigger* tab (the default values are quoted in the command description in chapter 6 of this manual).

Remote control `TRIGger[:SEQuence]:DEFault ON | OFF`

Meas. Trigger – Source *Source* selects the source for the trigger event:

Free Run	Free-run mode, the measurement is carried out continuously, it is not related to the input signal
RF Power	The measurement is triggered by the level (rising or falling edge; see *Slope* setting below) of the RF signal to be measured
IF Power	The measurement is triggered by the level of the IF signal
Extern	External trigger signal fed in via connector AUX3 (pin no. 8)

For the *RF Power* and *IF Power* trigger the trigger level is specified via the *Level* parameters. *RF Power* trigger signals have a small dynamic range which may not be sufficient for triggering. It is recommended to trigger by the *IF Power* instead.

Note: *If no measurement result can be obtained the trigger mode may not fit to the trigger signal applied. Check the trigger mode and signal.*

Remote control

```
TRIGger[:SEQuence]:SOURce
                  IMMediate | RFPower | IFPower | EXTern
```

Level

The *Level* section defines the trigger thresholds if the measurement is triggered by the *RF Power* or *IF Power* (see *Source* function above) respectively. Both thresholds are defined relative to the maximum input level set in the *Analyzer* tab (see *RF Max. Level* softkey on p. 4.59). The *Level* settings have no influence on *Free Run* or *External* trigger measurements.

Note: *The trigger levels are always relative to the* ***current*** *maximum input level. If RF Max. Level is set manually (RF Mode = Manual), the current input level is constant and equal to the setting value. In autoranging mode (RF Mode = Auto), the current maximum input level is dynamically adapted to the measured RF input level; the trigger levels change accordingly.*

The ***RF Power*** trigger threshold is the RF input signal level *(Wideband Power*, see p. 4.68) beyond which the trigger condition is satisfied and a measurement is initiated.

Low	Low trigger threshold, equal to approx. the *RF Max. Level* –26 dB
Medium	Medium trigger threshold, equal to approx. the *RF Max. Level* –16 dB
High	High trigger threshold, equal to approx. the *RF Max. Level* –6 dB

The ***IF Power*** trigger threshold is the IF trigger signal level beyond which the trigger condition is satisfied and a measurement is initiated. The *IF Power* input value defines the trigger threshold relative to the maximum input level:

IF power trigger threshold = <RF Max. Level> + <IF Power>

Remote control

```
TRIGger[:SEQuence]:THReshold:RFPower LOW | MEDium | HIGH
TRIGger[:SEQuence]:THReshold:IFPower <Power>
```

Slope

Slope qualifies whether the trigger event occurs on the *Rising Edge* or on the *Falling Edge* of the trigger signal. The setting has no influence on *Free Run* measurements.

Remote control

```
TRIGger[:SEQuence]:SLOPe  POSitive | NEGative
```

Ext. Trigger (AUX 3/4)

Ext. Trigger (AUX 3/4) qualifies whether the external trigger signal is fed in at *Pin 6, Pin 7*, or *Pin 8* of the AUX 3 connector. The setting only has effect if the trigger source is an *External* signal.

The CMU can be ordered with the auxiliary connector AUX 4 on the rear panel configured as an external trigger input. In this case the *Ext. Trigger...* pin selection refers to AUX 4; the front panel connector AUX 3 is disconnected.

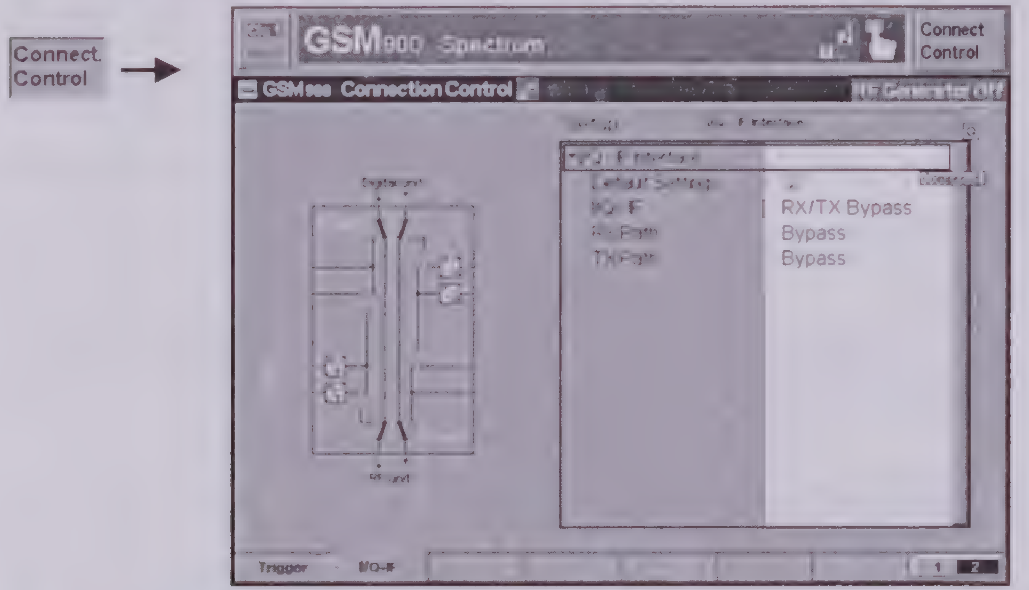
Remote control

```
TRIGger[:SEQuence]:SLOPe:EXTernal PIN6 | PIN7 | PIN8
```

I/Q-IF Interface (Connection Control – I/Q-IF)

The *I/Q-IF* tab is part of the second group of tabs in the *Connection Control* menu. It is accessible after pressing the *1 / 2* toggle hotkey once. Pressing *1 / 2* again switches back to the first group of tabs described above.

The *I/Q-IF* tab configures the signal paths for I/Q and IF signals. With option CMU-B17, *I/Q and IF Interfaces*, I/Q and IF signals can be used in the framework of *RF* measurements and in many network tests. For a detailed description of rear panel connectors for I/Q and IF input/output signals, test scenarios and application examples refer to section *I/Q and IF Interface (Option CMU-B17)* on p. 4.97 ff.



Default Settings
I/Q-IF RX/TX Bypass
RX Path Bypass
TX Path Bypass

Fig. 4-2 Connection Control – I/Q-IF

Default Settings The *Default Settings* checkbox assigns the default setting to all functions in the *I/Q-IF* tab.

Remote control `IQIF:DEFault ON | OFF`

I/Q-IF Selects the I/Q-IF test scenario, overwriting the current *RX Path* and *TX Path* settings. Six different predefined test scenarios with fixed RX and TX path are provided; see *Table 4-1 below*.

Additional scenarios may be defined by selecting any other combination of RX and TX paths. When this is done *I/Q-IF* is set to *User-defined*. The circuit diagram to the left of the *Setup* table shows the current RX and TX signal paths.

Remote control

```
CONFigure:IQIF:RXTXcombined
        BYP | BYIQ | XOIO | IOIO | IOXO | FPAT | UDEF
```

RX Path Selects the RX signal path, leaving the *TX Path* unchanged but adapting the I/Q-IF test scenario to the new RX/TX path combination: If the combination corresponds to a predefined scenario, then *I/Q-IF* is set to the predefined scenario; otherwise it is set to *User-defined*.

The circuit diagram to the left of the *Setup* table shows the current RX and TX signal paths.

Remote control

```
CONFigure:IQIF:RXPath
        BYP | BYIQ | XOIO | IOIO | IOXO | FPAT | UDEF
```

TX Path Selects the TX signal path, leaving the *RX Path* unchanged but adapting the I/Q-IF test scenario to the new RX/TX path combination: If the combination corresponds to a predefined scenario, then *I/Q-IF* is set to the predefined scenario; otherwise it is set to *User-defined*.

The circuit diagram to the left of the *Setup* table shows the current RX and TX signal paths.

Remote control

```
CONFigure:IQIF:TXPath
        BYP | BYIQ | XOIO | IOIO | IOXO | FPAT | UDEF
```

Table 4-1 I/Q-IF scenarios and path settings

I/Q-IF	**RX Path**	**TX Path**	**Remark/Application** (see also CMU manual)
RX/TX Bypass	Bypass	Bypass	No I/Q or IF inputs/outputs connected Direct signal analysis and transmission with full measurement accuracy
Byp. w. I/Q-OF OUT	Bypass w. I/Q-IF OUT	Bypass w. I/Q-IF OUT	No I/Q or IF inputs connected Analysis of received and transmitted signal via I/Q or IF
I/Q IN/OUT	I/Q IN/OUT	I/Q IN/OUT	Insertion of signal to be analyzed and transmitted on I/Q level
IF IN_I/Q IN/OUT	IF IN_I/Q IN/OUT	IF IN_I/Q IN/OUT	Additional processing of received and transmitted signal on IF level (filters etc.) and analysis via I/Q
IF IN/OUT	IF IN/OUT	IF IN/OUT	Insertion of signal to be analyzed and transmitted on IF level
Fading	Bypass	I/Q IN/OUT	Direct analysis of received signal Modification (fading) of transmitted signal by means of an external fading simulator (SMIQ, ABFS)
User-defined	Any combination of RX Path and TX Path not listed above		Any combination of RX and TX test cases listed above

Options and Extensions

The function groups described in this section require the installation of hardware options; for a complete list of deliverable options refer to the data sheet. Software options for digital and analog network tests are described in separate operating manuals; for a list refer to the *Manuals* section before tabbed divider no. 1 of this manual.

Audio Generator and Analyzer (Option CMU-B41)

Option CMU-B41, *Audio Generator and Analyzer*, provides an additional *Audio* function group comprising the functions for generating and measuring audio signals. It can be accessed either from the *Menu Select* menu (standalone audio measurements) or by switching over from any of the *GSM-MS*, *Bluetooth*, *cdmaOne (IS 95)-MS*, *CDMA2000*, or *TDMA (IS 136)-MS* measurement menus. In the latter case, the audio circuit of a mobile station can be tested without releasing a call connection or changing the signalling state of the CMU.

Standalone *audio* measurements are performed with default connector settings, the audio signals being applied to the connectors *AF IN/AUX 1* (input) and *AF OUT/AUX 2* (output) on the front panel of the instrument (see Chapter 1). If *Audio* is used in the context of the network tests *(Signalling* test mode), the *AF/RF* ·· tab of the associated *Connect. Control* menu allows to select the input source of the CMU speech encoder and the output destination of its speech decoder (for more information refer to the relevant network operating manuals).

Analyzer/Generator Menu

The main menu *Analyzer/Generator* defines the DC or sinusoidal AC signals generated by the two audio generators and displays the voltage of the two measured audio signals.

The measurement control softkey *Analyzer 1*, which changes to *Analyzer 2*, depending on the audio measurement application selected) controls the measurement, indicates its status *(RUN | HLT | OFF)* and opens the configuration menu *Audio Configuration*. The hotkeys associated to the measurement control softkey define the scope of the *Audio* measurement.

The other softkeys to the right of the test diagram are combined with various hotkeys (e.g. the hotkeys *AF Max. Level* and *AF Mode* belong to the softkey *Analyzer Level)*. The softkey/hotkey combinations provide test settings and switch over between different measurements.

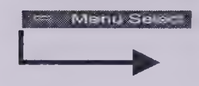
The *Analyzer/Generator* menu is opened from the main menu *Menu Select* (with associated key at front of instrument) or via the *Audio* hotkey which is available in all *GSM-MS*, *Bluetooth*, *cdmaOne (IS 95)-MS*, *CDMA2000*, or *TDMA (IS 136)-MS* measurement menus. Compared to the standalone case, the network audio option offers an extended functionality (see *Fig. 4-33* below):

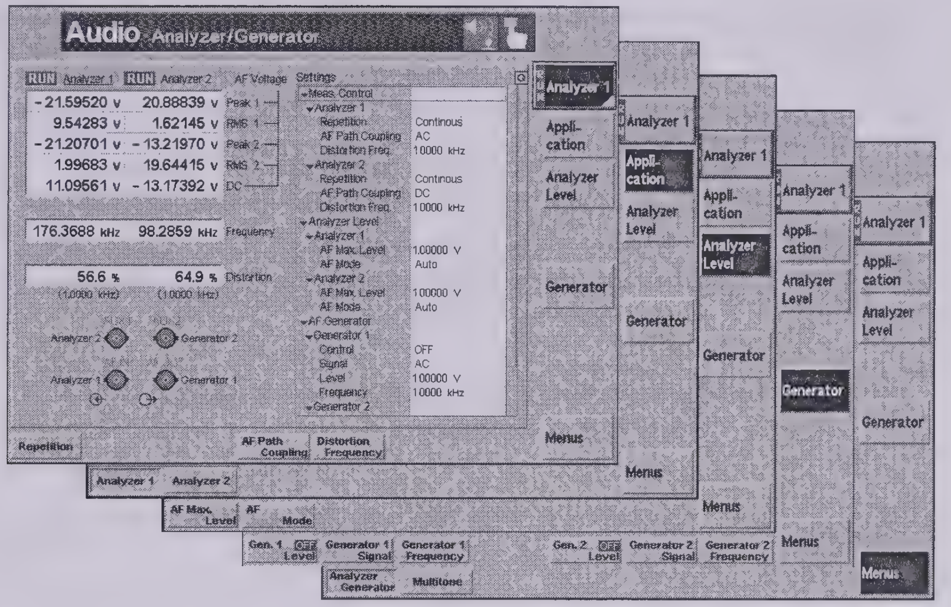
The *Connect. Control* softkey from the previous (calling) GSM function group is also available in *Audio*. The corresponding menu is described in the relevant operating manuals; see overview of CMU documentation at the beginning of the present CMU manual.

A symbol indicating the GSM test mode is displayed in the menu header.

A hotkey switching back to the GSM function group shows at the bottom of the menu.

The actual *Audio* functionality is identical in the standalone and network modes.


Menu Select


Audio Analyzer/Generator
RUN Analyzer 1
RUN Analyzer 2
AF Voltage
Settings
Analyzer 2
Generator 2
Analyzer 1
Generator 1
Analyzer 1
Application
Analyzer Level
Generator
Menus
Repetition
AF Path Coupling
Distortion Frequency
Analyzer 1
Analyzer 2
AF Max. Level
AF Mode
Gen. 1 OFF Level
Generator 1 Signal
Generator 1 Frequency
Gen. 2 OFF Level
Generator 2 Signal
Generator 2 Frequency
Analyzer Generator
Multitone

Analyzer 1	Analyzer 2	
-21.59520 V	20.88839 V	Peak 1
9.54283 V	1.62145 V	RMS 1
-21.20701 V	-13.21970 V	Peak 2
1.99683 V	19.64415 V	RMS 2
11.09561 V	-13.17392 V	DC
176.3688 kHz	98.2859 kHz	Frequency
56.6 % (1.0000 kHz)	64.9 % (1.0000 kHz)	Distortion

Settings	
Meas. Control	
Analyzer 1	
Repetition	Continous
AF Path Coupling	AC
Distortion Freq.	1.0000 kHz
Analyzer 2	
Repetition	Continous
AF Path Coupling	DC
Distortion Freq.	1.0000 kHz
Analyzer Level	
Analyzer 1	
AF Max. Level	1.00000 V
AF Mode	Auto
Analyzer 2	
AF Max. Level	1.00000 V
AF Mode	Auto
AF Generator	
Generator 1	
Control	OFF
Signal	AC
Level	1.00000 V
Frequency	1.0000 kHz
Generator 2	

Fig. 4-33 Measurement menu Analyzer/Generator (Audio)

Test Settings

The basic settings for the *Audio* measurement are directly accessible from the measurement menu via softkey/hotkey combinations. The entry of values is described in section *Test settings* on p. 4.40 ff.

Many of the basic settings are also accessible from the *Analyzer Configuration* popup menu. They are explained in more detail in section *Measurement Configurations (Analyzer Configuration)* on p. 4.81 ff.

Analyzer 1

The *Analyzer 1/2* softkey (which changes to Analyzer 2, depending on the application selected) controls the audio measurement (RUN / HLT / OFF) and indicates its status. This status can be changed after softkey selection (pressing once) by means of the ON/OFF key or the CONT/HALT key. The status can be set independently for all Audio applications.

Remote control
```
INITiate:AFANalyzer:<Applic>
STOP:AFANalyzer:<Applic>
ABORt:AFANalyzer:<Applic>
CONTinue:AFANalyzer:<Applic>

FETCh:AFANalyzer:<Applic>:STATus?
```

Measurement configuration

Pressing the *Analyzer* softkey twice opens the popup menu *Analyzer Configuration*; see p. 4.81 ff. Besides, the measurement control softkey provides hotkeys to define the scope of the measurement. All these settings are described in more detail in section *Measurement Control (Analyzer Configuration – Control)* on p. 4.81 ff.

Application

The Application softkey selects the audio measurement application.

The results of both applications *Analyzer 1* and *Analyzer 2* are indicated in the corresponding columns of the output tables; see section *Measurement Results* on p. 4.79 ff. The *Settings* table shows the measurement configurations for both applications. On the other hand, all softkeys and hotkeys in the measurement menu belong to the current application.

Analyzer 1

Analyzer 1 selects the primary audio circuit where the audio signals are applied to the connectors AF OUT (output, AF generator signal) and AF IN (input) on the CMU front panel.

Remote control:
The *Analyzer 1* application is selected by the keyword `[:PRIMary]` in the 3rd level of the analyzer commands, e.g. `INITiate:AFANalyzer[:PRIMary]`.

Analyzer 2

Analyzer 2 selects the secondary audio circuit where the audio signals are applied to the connectors AUX 2 (output, AF generator signal) and AUX 1 (input) on the CMU front panel.

Remote control:
The *Analyzer 2* application is selected by the keyword `:SECondary` in the 3rd level of the analyzer commands, e.g. `INITiate:AFANalyzer:SECondary`.

Analyzer Level

The *Analyzer Level* softkey controls the level in the AF input signal path.

AF Max. Level

The *AF Max. Level* hotkey sets the maximum expected AF input level. Levels exceeding this value can not be measured.

Remote control
`[SENSe:]AFLEVel:MAXimum <Level>`

Error messages

If the value set for *Manual Level* is too high or too low, a window with the error message *"<Max_Level> is out of range. <permissible max. value> is limit."* and three fields will appear:

Accept	The permissible max. value is accepted as maximum input level.
Re-edit	The *Manual Level* is entered once again.
Cancel	The last valid input value is maintained.

AF Mode

The *AF Mode* hotkey determines how the input level is defined.

Manual	Manual input of maximum input level via *Manual Level* (in mV).
Auto	Automatic setting of maximum input level *(autoranging)* according to average power of applied AF signal (plus an appropriate overload margin).

Note1: *A maximum input level can be entered even if automatic level setting (autoranging) is selected. It serves as a start value for the autoranging algorithm and is important to ensure safe switchover to manual setting.*

Note2: *The AF Max. Level and AF Mode settings supersede the corresponding settings in the Multitone menu (Analyzer 1/2); see hotkeys AF Max. Level on p. 4.86 and AF Mode on p. 4.87.*

Remote control
`[SENSE:]AFLevel:MODE  MANual | AUTomatic`

Generator

The *Generator* softkey controls the audio generator and defines the properties of the generated DC or sinusoidal AC signal. The three hotkeys for the primary and secondary audio circuit *(Gen. 1/Gen. 2)* are analogous.

The generator settings are also provided in the *Analyzer Configuration* menu; see section *Generator Settings (Analyzer Configuration – Generator)* on p. 4.82 ff.

GSM 900 –MS Sign.

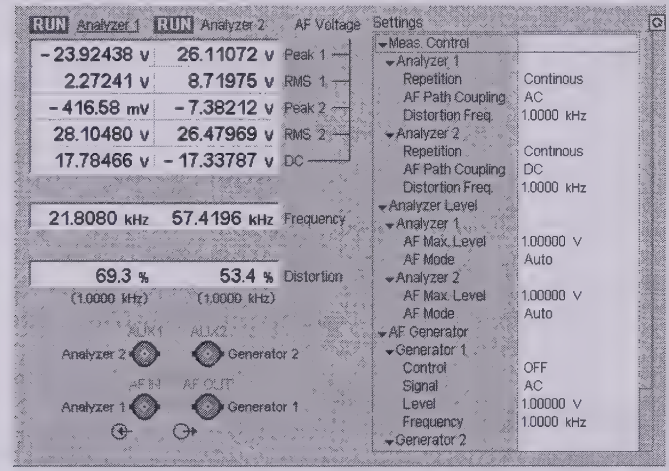
The hotkey switches back to the previous GSM function group.

This hotkey is available if the *Analyzer/Generator* menu is opened from a GSM function group. The hotkey is labeled with the calling function group and test mode, which is also displayed in the menu header.

Remote control
All function groups for network tests are referenced by their secondary addresses; see Chapter 5.

Measurement Results

The test settings of the current *Audio* measurement and the results are displayed in the tables in the center of the menu.



Analyzer 1	Analyzer 2	AF Voltage
-23.92438 V	26.11072 V	Peak 1
2.27241 V	8.71975 V	RMS 1
-416.58 mV	-7.38212 V	Peak 2
28.10480 V	26.47969 V	RMS 2
17.78466 V	-17.33787 V	DC
21.8080 kHz	57.4196 kHz	Frequency
69.3 % (1.0000 kHz)	53.4 % (1.0000 kHz)	Distortion

Settings

- Meas. Control
  - Analyzer 1
    - Repetition: Continous
    - AF Path Coupling: AC
    - Distortion Freq.: 1.0000 kHz
  - Analyzer 2
    - Repetition: Continous
    - AF Path Coupling: DC
    - Distortion Freq.: 1.0000 kHz
- Analyzer Level
  - Analyzer 1
    - AF Max. Level: 1.00000 V
    - AF Mode: Auto
  - Analyzer 2
    - AF Max. Level: 1.00000 V
    - AF Mode: Auto
- AF Generator
  - Generator 1
    - Control: OFF
    - Signal: AC
    - Level: 1.00000 V
    - Frequency: 1.0000 kHz
  - Generator 2

Fig. 4-34 Display of test settings and measurement results (Audio)

Results

The table and output fields in the left half of the table show the results for both audio circuits (applications *Analyzer 1* and *Analyzer 2).* If an analyzer is switched off (see measurement control softkey *Analyzer 1* on p. 4.77), *OFF* is indicated above the corresponding output column and the output fields show invalid results ("---").

The values in the *AF Voltage* table represent the measured voltages of the AF signals:

Peak 1/2	Peak value of the AC component of the measured AF signal in V. The numbers 1 and 2 denote two different input paths for AF signals with different filter configuration; see *Fig. 4-37* on p. 4.83.
RMS 1/2	Effective (RMS-averaged) value of the AC component of the measured AF signal in V.
DC	DC component of the measured AF signal in V
Frequency	Frequency of the measured AC signal
Distortion	Ratio of the measured AF signal with a notched-out reference frequency to the complete measured AF signal in percent. The reference frequency of the distortion measurement set in the Distortion tab of the configuration menu (see p. 4.82) is indicated in brackets below the output field. If the reference frequency is equal to the fundamental frequency of the AF signal, the Distortion value corresponds to the Total Harmonic Distortion and Noise. To avoid suppression of the first harmonic, the bandwidth of the notch filter is automatically adjusted to be smaller than the reference frequency.

Remote control

```
READ[:SCALar]:AFANalyzer:<Applic>[:RESult]?
FETCh[:SCALar]:AFANalyzer:<Applic>[:RESult]?
SAMPle[:SCALar]:AFANalyzer:<Applic>[:RESult]?
```

AF Connector Overview

The figure below the result table shows the destination of the input signals fed in via AF IN and AUX 1 and the signal sources for the two audio output connectors AF OUT and AUX 2.

For standalone audio measurements and network tests in *Non Signalling* mode the routing of input and output signals is fixed: The connectors AF IN and AF OUT are used as input and output for the primary audio circuit (Analyzer 1, Generator 1). AUX 1 and AUX 2 are used as input and output for the secondary audio circuit (Analyzer 2, Generator 2).

If network tests are performed in *Signalling* mode and a speech codec is available, the routing of input and output signals is is a function of the *Speech Decoder* output destination. For more information refer to the network test manuals.

Settings

The *Settings* table gives an overview of the configuration of the current measurements. This includes the settings made via the softkeys and hotkeys of the *Audio* menu.

Remote control

Settings are read out using the query corresponding to the setting command (setting command with appended question mark). See section *Test Settings* on p. 4.77 ff..

Measurement Configurations (Analyzer Configuration)

The popup menu *Analyzer Configuration* contains three tabs to determine the parameters of the *Audio* measurement. It is opened by pressing the softkey *Analyzer* in the measurement menu *Analyzer/Generator* twice. It is possible to change between the tabs by pressing the associated hotkeys.

The popup menu *Analyzer Configuration* is activated by pressing the measurement control softkey at the top right in the graphical measurement menu *Power* twice. It is possible to change between the tabs by pressing the associated hotkeys.

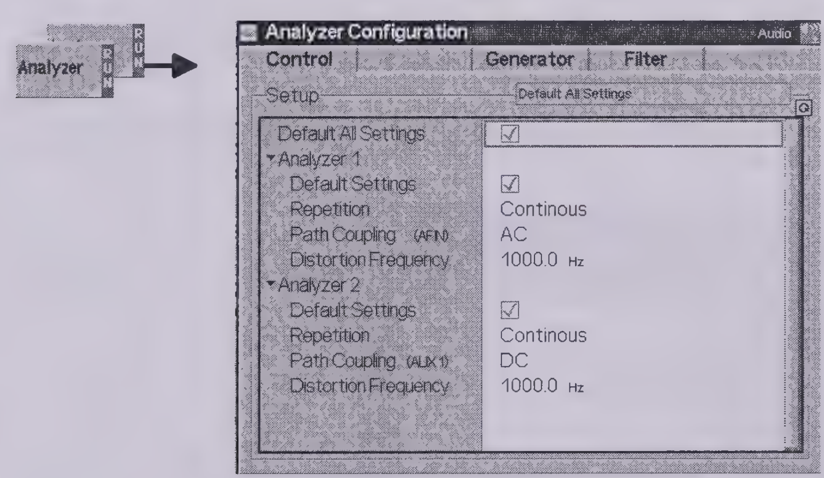
Measurement Control (Analyzer Configuration – Control)

The *Control* tab determines:
The *Repetition* mode,

The *AF Path Coupling* of the audio measurement.

The reference frequency of the distortion measurement *(Distortion Frequency)*.

The settings can be defined independently for the applications *Analyzer 1* and *Analyzer 2*.



Default All Settings ☑
Analyzer 1
Default Settings ☑
Repetition Continous
Path Coupling (AFIN) AC
Distortion Frequency 1000.0 Hz
Analyzer 2
Default Settings ☑
Repetition Continous
Path Coupling (AUX 1) DC
Distortion Frequency 1000.0 Hz

Fig. 4-35 Analyzer Configuration – Control

Default Settings The *Default* switch assigns default values to all settings in the *Control* tab (the default values are quoted in the command description in chapter 6 of this manual). In addition, default switches for the individual applications are provided.

Remote Control
–

Repetition The *Repetition* field determines the repetition mode, see chapter 3 and explanations given on page 4.46 for the *Power* measurement. In *Audio*, one statistics cycle is terminated when the system has settled and a valid result is available.

Remote control
```
CONFigure:AFANalyzer:<Applic>:CONTrol:REPetition
       CONTinuous | SINGleshot | 1 ... 10000,NONE,<Stepmode>
```

Path Coupling *Path Coupling* sets the input path for measurement of the AC or AC and DC component of the AF signal:

AC	DC component of the measured AF signal (including a possible DC offset of the input amplifier) blocked. This ensures accurate measurement of the AC component. The DC component, however, can not be measured.
DC	Measurement of the complete AF input signal (DC plus AC components).

Note: *The path coupling has an impact on the allowed filter settings; see section Input Path Configuration (Analyzer Configuration – Filter) on p. 4.82 f.*

Remote control
`CONFigure:AFANalyzer:<Applic>:CONTrol:COUPling  AC | DC`

Distortion Frequency *Distortion Frequency* defines the reference frequency of the distortion measurement. If the reference frequency is set to the fundamental frequency of the AF signal, the *Distortion* value corresponds to the Total Harmonic Distortion and Noise.

Remote control
`CONFigure:AFANalyzer:<Applic>:CONTrol:DIStortion:FREQuency`

Generator Settings (Analyzer Configuration – Generator)

The *Generator* tab defines the properties of the generated AF signals. The settings can be defined independently for the two AF generators.

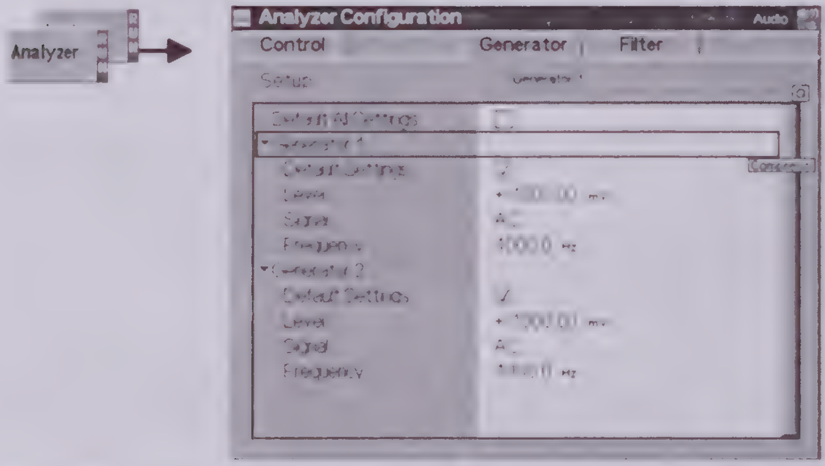


Fig. 4-36 Analyzer Configuration – Generator

Default Settings The *Default Settings* switch assigns default values to all settings in the *Generator* tab (the default values are quoted in the command description in chapter 6 of this manual). In addition, default switches for the two independent generators are provided.

Remote Control
–

Level	*Level* defines the generator level in mV. The meaning of the entered level depends on the generator signal type (see *Signal* below): If the generated signal is an AC signal, *Level* denotes the effective (RMS averaged) voltage. If the generated signal is an DC signal, *Level* denotes the constant DC voltage. Remote control `SOURce:AFGenerator:<Applic>:LEVel <Level>`
Signal	*Signal* qualifies whether the generated audio signal is a DC or an AC signal. Remote control `SOURce:AFGenerator:<Applic>:SMODe DC | AC`
Frequency	*Frequency* sets the frequency of the generated AF audio signal in Hz. The hotkey is disabled if the generated signal is a DC signal. Remote control `SOURce:AFGenerator:<Applic>:FREQuency <Frequency>`

Input Path Configuration (Analyzer Configuration – Filter)

The *Filter* tab configures the different filter stages for the AF analyzer. The input path for measuring the AC component of the AF signal is as shown below:

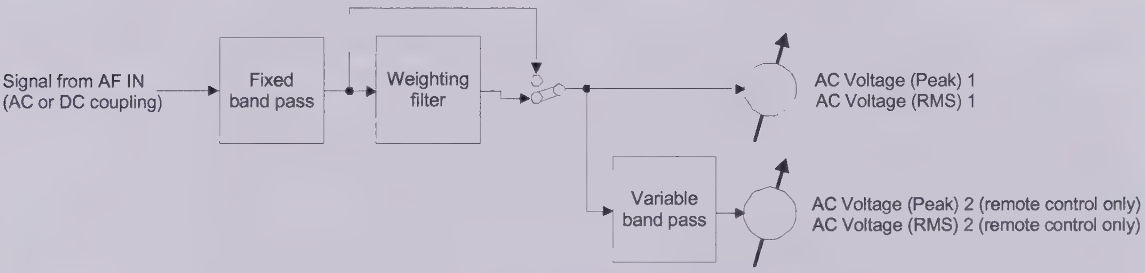
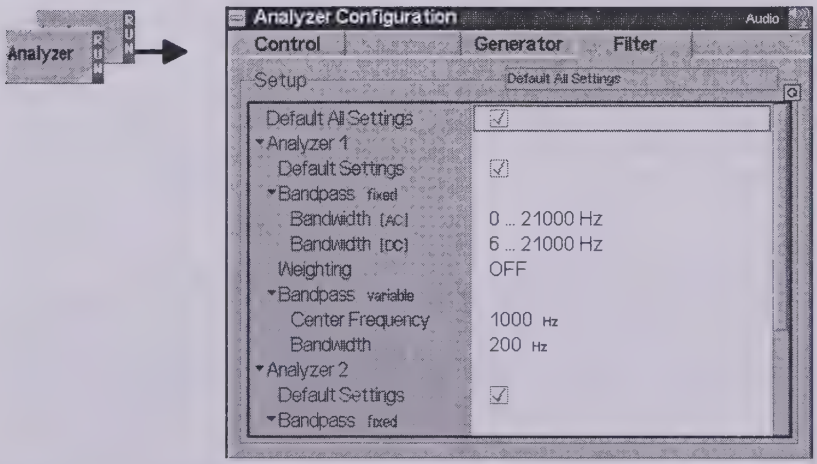

Signal from AF IN
(AC or DC coupling)
Fixed band pass
Weighting filter
AC Voltage (Peak) 1
AC Voltage (RMS) 1
Variable band pass
AC Voltage (Peak) 2 (remote control only)
AC Voltage (RMS) 2 (remote control only)

Fig. 4-37 AF analyzer input path configuration


Analyzer
RUN
Analyzer Configuration
Audio
Control
Generator
Filter
Setup
Default All Settings

Default All Settings ☑
Analyzer 1
Default Settings ☑
Bandpass fixed
Bandwidth [AC] 0 ... 21000 Hz
Bandwidth [DC] 6 ... 21000 Hz
Weighting OFF
Bandpass variable
Center Frequency 1000 Hz
Bandwidth 200 Hz
Analyzer 2
Default Settings ☑
Bandpass fixed

Fig. 4-38 Analyzer Configuration – Filter

Default Settings

The *Default Settings* switch assigns default values to all settings in the *Filter* tab (the default values are quoted in the command description in chapter 6 of this manual).

Remote Control

Bandpass

The *Bandpass* section sets the bandwidth of the fixed band pass (see *Fig. 4-37 above*).

Bandwidth (AC Coup.)	Bandwidth to be used if the AF path coupling is set to AC (see *Path Coupling* on page 4.82)
Bandwidth (DC Coup.)	Bandwidth to be used if the AF path coupling is set to DC

The CMU provides a broad selection of bandwidths with lower cutoff frequencies between 0 Hz and 300 Hz and upper cutoff frequencies between 250 Hz and 21 kHz (see command description in Chapter 6).

Note: *If the AF Path Coupling is set to DC, the audio analyzer receives the complete AF input signal including a possible DC component. To avoid measurement inaccuracies, band pass filters with a lower cutoff ≥ 6 Hz are available only.*

Remote control

```
CONFigure:AFANalyzer:<Applic>:FILTer:BPASs:ACCoupling
CONFigure:AFANalyzer:<Applic>:FILTer:BPASs:DCCoupling
```

Weighting

The *Weighting* section selects a weighting filter to be switched into the AF signal path after the fixed band pass (see *Fig. 4-37 above*).

C-Message	Swith on C-message weighted filter
CCITT	Swith on CCITT weighting filter
Off	No weighting filter

Remote control

```
CONFigure:AFANalyzer:<Applic>:FILTer:WEIGhting
```

Bandpass (variable)

The *Bandpass (variable)* section sets the center frequency and the bandwidth of the variable band pass.

Note: *The variable band pass settings affect the results for AC Voltage (Peak) 2 and AC Voltage (RMS) 2 only (see Fig. 4-37 above). These quantities are available in remote control but not displayed in the Analyzer/Generator menu.*

Remote control

```
CONFigure:AFANalyzer:<Applic>:FILTer:VBPass:CFRequency
CONFigure:AFANalyzer:<Applic>:FILTer:VBPass:BWIDth
```

Multitone Measurement

The graphical measurement menu *Multitone* shows the results of the multitone audio measurement.

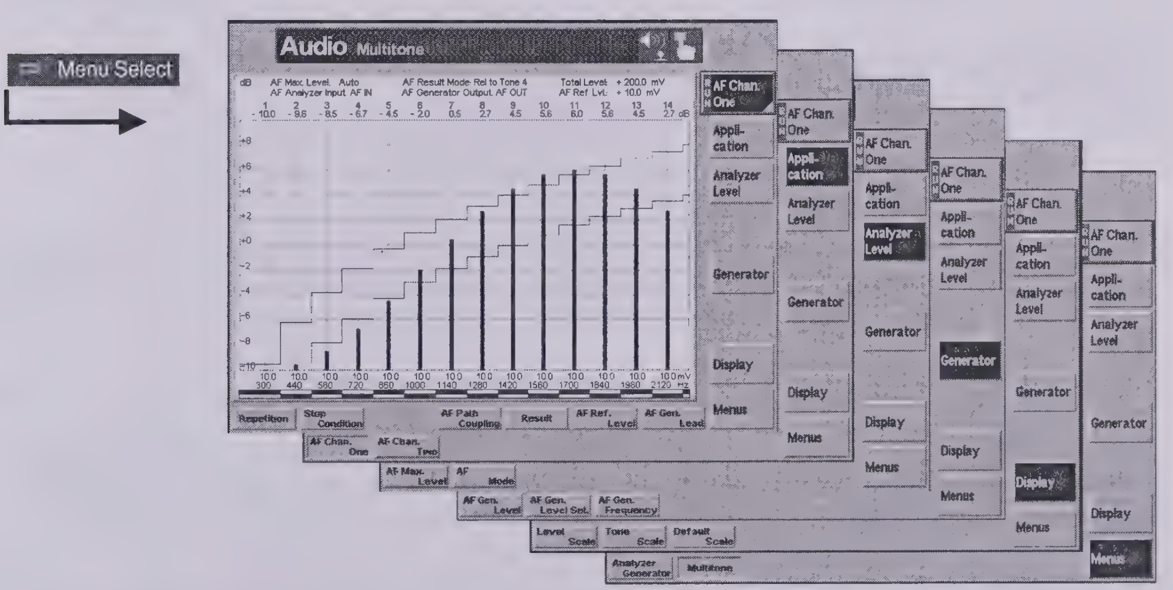
To perform an *Multitone* measurement, the CMU generates a composite audio signal that represents the superposition of up to 20 individual fixed-frequency tones with configurable frequency and level. An audio signal containing the same tones can be analyzed in a single measurement and displayed in a bar chart.

The *Multitone* measurement is thus a fast method to determine the level of up to 20 different tones at known frequencies and to perform a limit check for all results. Possible applications are also frequency response and intermodulation measurements.

The main softkey *AF Chan. One,* which changes to *AF Chan. Two* if the corresponding application is selected, controls the *Multitone* measurement, indicates its status *(RUN | HLT | OFF)* and opens the configuration menu *Multitone Configuration* (press twice). The hotkeys associated to the main softkey define the scope of the *Multitone* measurement.

The other softkeys to the right of the test diagram are combined with various hotkeys (e.g. the hotkeys *AF Max. Level* and *AF Mode* belong to the softkey *Analyzer Level)*. If a softkey is selected and an associated hotkey is pressed, a popup window will appear which indicates the current setting and enables an entry (for an example, see section *Test settings* on page 4.40 ff.).

The measurement menu *Multitone* is opened via the main menu *Menu Select* (with the associated key at the front of the instrument) or from the *Analyzer/Generator* menu using the *Multitone* hotkey.


AF Max. Level: Auto
AF Analyzer Input: AF IN
AF Result Mode: Rel to Tone 4
AF Generator Output: AF OUT
Total Level: + 200.0 mV
AF Ref Lvl: + 10.0 mV

Menu Select
Audio Multitone
dB
1 2 3 4 5 6 7 8 9 10 11 12 13 14
- 10.0 - 9.6 - 8.5 - 6.7 - 4.5 - 2.0 0.5 2.7 4.5 5.6 6.0 5.6 4.5 2.7 dB
+8 +6 +4 +2 +0 -2 -4 -6 -8 -10
10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 mV
300 440 580 720 860 1000 1140 1280 1420 1560 1700 1840 1980 2120 Hz
AF Chan. One
Appli-cation
Analyzer Level
Generator
Display
Menus
Repetition
Stop Condition
AF Path Coupling
Result
AF Ref. Level
AF Gen. Lead
AF Chan. One
AF Chan. Two
AF Max. Level
AF Mode
AF Gen. Level
AF Gen. Level Sel.
AF Gen. Frequency
Level Scale
Tone Scale
Default Scale
Analyzer Generator
Multitone

Fig. 4-39 Measurement menu Multitone

Test Settings

The *Multitone* measurement can be configured by means of the softkeys and hotkeys in the graphical measurement menu.

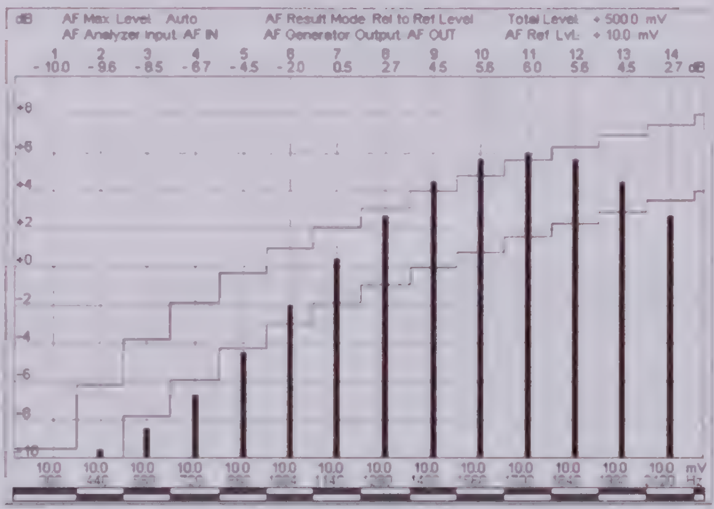
Remote control
no remote control command; screen configuration only

Menus

The *Menus* softkey displays the hotkey bar for switching over to the other measurement menus.

Measurement Results

The *Multitone* measurement menu displays the individual levels at up to 14 out of 20 different test tones, corresponding to 20 (not necessarily distinct) audio input frequencies. The results and the test settings are indicated in two parameter lines and the actual test diagram (bar graph) with its axis labels:



Parameter lines

Test tone no. and frequency response

Bar graph with upper and lower limit lines

Test tone voltage and frequency

dB AF Max. Level Auto AF Result Mode Rel to Ref Level Total Level: + 500.0 mV
AF Analyzer Input AF IN AF Generator Output AF OUT AF Ref Lvl: + 10.0 mV

1 2 3 4 5 6 7 8 9 10 11 12 13 14
- 10.0 - 9.6 - 8.5 - 6.7 - 4.5 - 2.0 0.5 2.7 4.5 5.8 6.0 5.8 4.5 2.7 dB
+8
+6
+4
+2
+0
-2
-4
-6
-8
-10
10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 mV
Hz

Fig. 4-40 Display of measurement results (Multitone)

Parameter lines The first parameter line contains the following settings and results:

AF Max. Level	Maximum AF input level in mV as set by means of the *AF Max. Level* softkey described on p. 4.86.
AF Result Mode	Reference value for all levels as set in the configuration menu (see section *Measurement Control (Multitone Configuration – Control)* on p. 4.89 ff.)
Total Level	Sum of the individual levels of all test tones measured in mV.

The second parameter line contains the following settings:

AF Analyzer Input	Input connector used for the Multitone measurement. In the AF Chan. One application, AF IN is used.
AF Generator Output	Output connector used for the Multitone measurement. In the AF Chan. One application, AF OUT is used.
AF Ref. Lvl	0-dB line in the test diagram as set in the configuration menu (see section *Measurement Control (Multitone Configuration – Control)* on p. 4.89 ff.).

Remote control
The settings are read out using the query corresponding to the setting command (setting command with appended question mark).

Bar graph The bar graph shows the AF level in dB at a maximum of 14 out of 20 different audio frequencies corresponding to a continuous range of test tones configured in the *Tone Def.* tab of the configuration menu (see p. 4.93 ff.). If a test tone is disabled in the configuration menu, the corresponding bar is omitted.

Frequency axis (abscissa) The range of test tones (no. 1 to 14, 2 to 15 etc.) to be viewed can be selected via the *Display – Tone Scale* hotkey (see p. 4.87). The bars representing the level of the different tones are equidistantly distributed over the whole diagram width. This optimizes the readability of the diagram but implies that the abscissa scale is not necessarily linear. Therefore, the frequency and voltage of every single test tone is displayed below the frequency axis.

Frequency response axis (ordinate) The ordinate can be arbitrarily scaled by setting a maximum and minimum value (both in dB). With a fixed ordinate, the adjustable 0 dB reference line (see *Level Scale* hotkey on p. 4.87) allows to shift the whole diagram vertically.

Remote control
`READ:ARRay:MULTitone:AFxChannel?` etc.
`READ[:SCALar]:MULTitone:AFxChannel:TONE<nr>?` etc. `(x = 1,2)`

Limit Check The upper and lower limit lines for each test point defined in the *Limit Lines* tab of the configuration menu (see p. 4.92) correspond to the two red step functions in the diagram. If the result at a particular test point exceeds the upper limit (falls below the lower limit), the corresponding section of the upper (lower) bar across the bottom of the diagram turns red.

Remote control

```
CALCulate:ARRay:MULTitone:AFxChannel:MATChing:LIMit?
CALCulate[:SCALar]:MULTitone:AFxChannel:TONE<nr>:MATChing:
      LIMit?
CALCulate[:SCALar]:MULTitone:AFxChannel:MATChing:LIMit?
                  (x = 1,2)
```

Measurement Configurations (Multitone Configuration)

The popup menu *Multitone Configuration* contains four tabs which determine the parameters of the *Multitone* measurement including the error tolerances.

The popup menu *Multitone Configuration* is activated by pressing the main softkey (labeled *AF Chan. One* or *AF Chan. Two*, depending of the application selected) in the measurement menu *Multitone* twice. It is possible to change between the tabs by pressing the associated hotkeys.

Measurement Control (Multitone Configuration – Control)

The *Control* tab controls the *Multitone* measurement by determining
The Repetition mode

The *Stop Condition* for the measurement

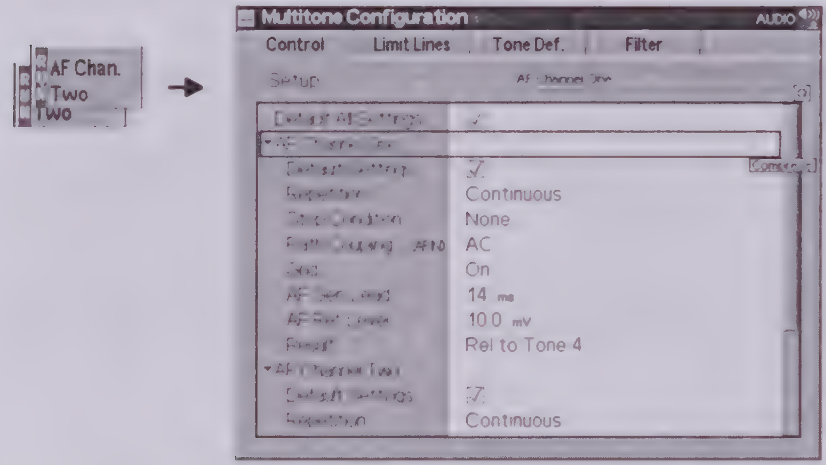
The AC or DC input *Path Coupling*

A settling time for the AF generator *(AF Generator Lead)*

The 0-dB line in the graphical diagram *(AF Ref. Level)*

Reference value for all levels in the graphical diagram *(Result)*

Besides, it configures the measurement diagram by adding or removing the *Grid*. All parameters can be set independently for the two AF channels 1 and 2.



✓
✓
Continuous
None
AC
On
14 ms
10.0 mV
Rel to Tone 4
✓
Continuous

Fig. 4-41 Multitone Configuration – Control

Default Settings The *Default* switch assigns default values to all settings in the *Control* tab (the default values are quoted in the command description in chapter 6 of this manual). Two additional default switches reset all *AF Channel One* or all *AF Channel Two* settings, respectively.

Remote Control

```
CONFigure:MULTitone:AFxChannel:CONTrol:REPetition
      DEF, DEF, DEF  (x = 1,2)
```

Repetition *Repetition* determines the repetition mode, see chapter 3 and explanations given on page 4.46 for the *Power* measurement. In *Audio*, one statistics cycle is terminated when the system has settled and a valid result is available.

Remote control

```
CONFigure:MULTitone:AFxChannel:CONTrol:REPetition    (x = 1,2)
       CONTinuous | SINGleshot | 1 ... 10000,NONE,<Stepmode>
```

Stop Condition *Stop Condition* defines a stop condition for the measurement:

None	Continue measurement even if tolerance is exceeded
On Limit Failure	Stop measurement if tolerance is exceeded

Remote control

```
CONFigure:MULTitone:AFxChannel:CONTrol:REPetition   (x = 1,2)
      CONTinuous | SINGleshot | 1 ... 10000,NONE,<Stepmode>
```

AF Path Coupling *AF Path Coupling*sets the input path for measurement of the AC or AC and DC component of the AF signal:

AC DC component of the measured AF signal (including a possible DC offset of the input amplifier) blocked. This ensures accurate measurement of the AC component. The DC component, however, can not be measured.

DC Measurement of the complete AF input signal (DC plus AC components).

Note: *The AF path coupling has an impact on the allowed filter settings; see section Input Path Configuration (Multitone Configuration – Filter) on p. 4.94 f.*

Remote control

```
CONFigure:MULTitone:AFxChannel:COUPling  AC | DC
            (x = 1,2)
```

AF Generator Lead *AF Generator Lead* defines a settling time for the measurement to be applied after a change of the generator settings. A small value accelerates the measurement but may impair its accuracy.

Remote control

```
CONFigure:MULTitone:AFxChannel:AFGLead <Time> (x = 1,2)
```

AF Ref. Level *AF Ref. Level* defines an audio reference level. The reference level is entered as an RMS voltage (in mV) and defines the 0 dB line of the test diagram provided that *Relative to Ref. Lev.* is selected as *Result* (see below).

Remote control

```
CONFigure:MULTitone:AFxChannel:RLEVel <Voltage> (x = 1,2)
```

Result The *Result* function defines the reference value for all measurement results. This corresponds to the 0 dB reference line in the diagram.

Relative to Ref. Lev.	All results are referenced to the AF Ref. Level; see above
Relative to Tone 1	All results are referenced to the measurement result at tone 1 (if available)
...	
Relative to Tone 20	All results are referenced to the measurement result at tone 20 (if available)

The measurement is taken at up to 20 audio frequencies (tone 1 to 20) which can be defined and switched on or off in the *Tone Def.* tab of the configuration menu (see page 4.93 ff.).

Remote control

```
CONFigure:MULTitone:AFxChannel:RMODe  RLEV | TON<nr>
            (x = 1,2)
```

Limit Lines (Multitone Configuration – Limit Lines)

The *Limit Lines* tab defines upper and lower limits for the audio level at all test tones and enables or disables the limit check. All parameters can be set independently for the two AF channels 1 and 2.

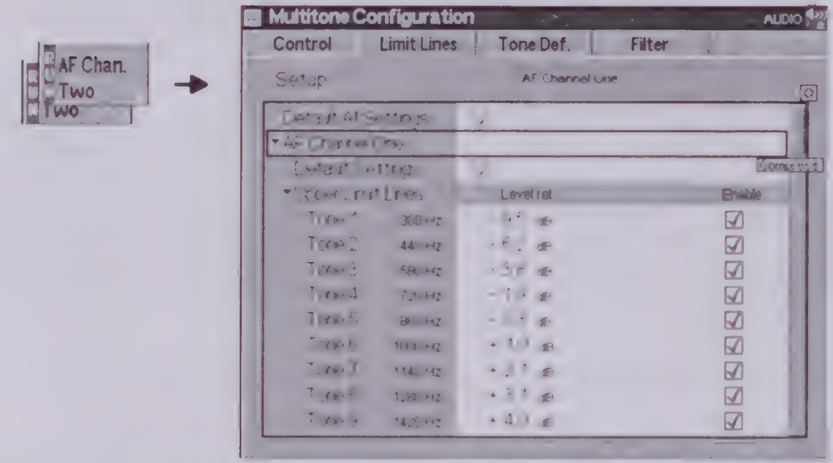


Fig. 4-42 Multitone Configuration – Limit Lines

Default Settings The *Default All Settings* switch assigns default values to all fields in the *Limit Lines* tab (the default values are quoted in the command description in chapter 6 of this manual). Two additional default switches reset all *AF Channel One* or all *AF Channel Two* settings, respectively.

Remote control

```
DEFault:MULTitone:LIMit:LINE  ON | OFF
DEFault:MULTitone:AFxChannel:LIMit:LINE  ON | OFF (x = 1,2)
```

Upper Limit Line/ Lower Limit Line Upper and lower limit lines for all 20 test points can be defined separately in the two table sections *Upper Limit Line* and *Lower Limit Line*.

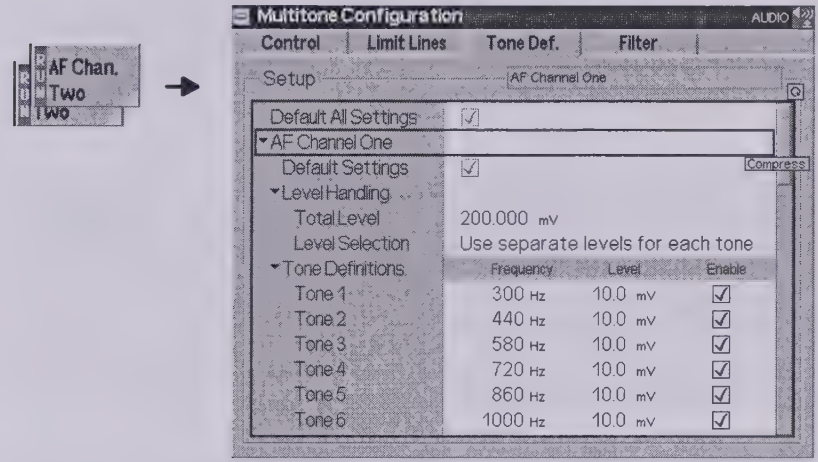
The tone nos. and the corresponding frequencies are indicated in the two left columns of the table as defined in the *Tone Def.* tab (see p. 4.93). For each tone, the upper and lower limit can be entered as a single value in dB. The corresponding *Enable* checkbox switches the limit line in the test diagram and the limit check on (if checked) or off.

Remote control

```
CONFigure:MULTitone:AFxChannel:LIMit:LINE:ASYMmetric:UPPer
       <Limit_1>, <Enable_1>...
CONFigure:MULTitone:AFxChannel:TONE<nr>:LIMit:LINE
          :ASYMmetric:UPPer <Limit>, <Enable>
CONFigure:MULTitone:AFxChannel:LIMit:LINE:ASYMmetric:LOWer
          <Limit_1>, <Enable_1>...
CONFigure:MULTitone:AFxChannel:TONE<nr>:LIMit:LINE
          :ASYMmetric:LOWer <Limit>, <Enable>   (x = 1,2)
```

Test Tones (Multitone Configuration – Tone Def.)

The *Tone Def.* tab configures the audio test signal generated by the CMU. This signal is composed of up to 20 test tones with different frequencies and levels. All parameters can be set independently for the two AF channels 1 and 2.



Default All Settings ☑

AF Channel One

Default Settings ☑

Level Handling

Total Level 200.000 mV

Level Selection Use separate levels for each tone

Tone Definitions	Frequency	Level	Enable
Tone 1	300 Hz	10.0 mV	☑
Tone 2	440 Hz	10.0 mV	☑
Tone 3	580 Hz	10.0 mV	☑
Tone 4	720 Hz	10.0 mV	☑
Tone 5	860 Hz	10.0 mV	☑
Tone 6	1000 Hz	10.0 mV	☑

Fig. 4-43 Multitone Configuration – Tone Def.

Default Settings The *Default All Settings* switch assigns default values to all fields in the *Tone Def.* tab (the default values are quoted in the command description in chapter 6 of this manual). Two additional default switches reset all *AF Channel One* or all *AF Channel Two* settings, respectively.

Remote control
`DEFault:MULTitone:FILTer ON | OFF`
`DEFault:MULTitone:AFxChannel:FILTer ON | OFF (x = 1,2)`

Level Handling: Total Level *Total Level* defines the sum of the individual voltages of all enabled tones. The meaning of the total level depends on the *Level Selection* setting (see below):

If *Level Selection* is set to *Use Separate Levels,* a separate AF level (in mV) can be assigned to each of the 20 test tones.

If *Level Selection* is set to *Use Total Level,* a single sum level (also in mV) is defined for the whole multitone signal. This level is evenly distributed among all enabled test tones.

The *Total Level* entered must not exceed the maximum level of the AF generator quoted in the data sheet.

Remote control
`CONFigure:MULTitone:AFxChannel:TDEFinition:TLEVel (x = 1,2)`

Level Selection The *Level Selection* table section defines how the voltage of each of the test tones is determined:

Use separate levels for each tone
A separate AF level (in mV) can be assigned to each of the 20 test tones. The *Total Level* is ignored. It can still be edited for future measurements where the *Level Selection* parameter is set to *Manual.*

Use Total Level A single sum level (also in mV) is defined for the whole multitone signal. This level is evenly distributed among all enabled test tones. This means that the level of each enabled test tone is set to *Total Level / n* where n is the number of enabled test tones (n = 1 to 20). If a test tone is disabled, the total level is maintained and the share of the remaining test tones in the total level increases.

Remote control

```
CONFigure:MULTitone:AFxChannel:TDEFinition:MODE   (x = 1,2)
        SEParate | TLEVel
```

Tone Definitions The *Tone Definitions* table assigns an audio *Frequency* (in Hz) and *Level* (RMS voltage in mV) to each of the 20 test tones.

The frequencies must be multiples of 1 Hz. It is possible, however, to define several tones at the same frequency, or to number the tones in arbitrary order: The x-axis is scaled by the **number** of the test tones, not by their frequency. The RMS voltages of different tones may coincide and can vary within the range quoted in the remote control command description in chapter 6 of this manual. The sum of all test tones must not exceed the maximum level of the AF generator quoted in the data sheet.

Note: *The voltages of all test tones enabled can be set manually or automatically, depending on the setting of the* Level Selection *parameter described above.*

The *AF Gen.* checkbox switches the tone in the audio signal and the corresponding bar in the test diagram on (if checked) or off.

Remote control

```
CONFigure:MULTitone:AFxChannel:TDEFinition
        <Freq 1>,<Level 1>,<Enable 1>,...
CONFigure:MULTitone:AFxChannel:TDEFinition:TONE<nr>
        <Freq>,<Level>,<Enable>,... (x = 1,2)
```

Input Path Configuration (Multitone Configuration – Filter)

The *Filter* tab configures the receive path of the CMU for the *Multitone* measurement (see *Fig. 4-44* below). All parameters can be set independently for the two AF channels 1 and 2.

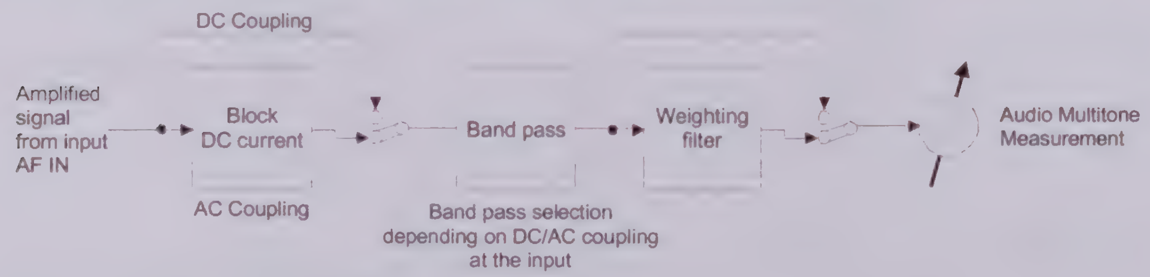
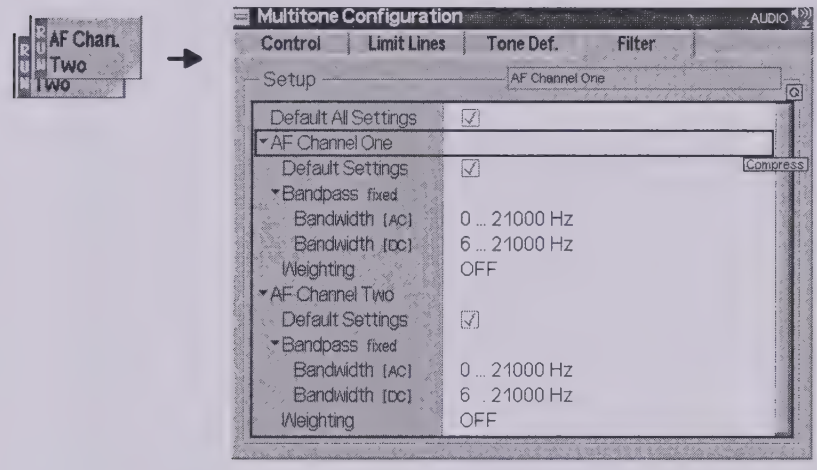

DC Coupling
Amplified signal from input AF IN
Block DC current
Band pass
Weighting filter
Audio Multitone Measurement
AC Coupling
Band pass selection depending on DC/AC coupling at the input

Fig. 4-44 Signal path for Multitone measurements

The audio receive path of the CMU may contain the following filter stages:

AF Path Coupling	Capacitor stage to block the DC component of the AF input signal including a possible DC offset of the input amplifier. With DC coupling, the complete AF input signal is measured.
Weighting	Weighting filter according to CCITT or C-message weighted filter.
Band Pass	Audio band pass filter with selectable bandwidth to limit the input frequencies to a definite audio band and eliminate unwanted signal components. The allowed bandwidth depends on the *AF Path Coupling*.

The audio results are generated at the end of the audio receive path, after the audio signal has passed all filter stages that are switched on.



Default All Settings ☑
AF Channel One
Default Settings ☑
Bandpass fixed
Bandwidth [AC] 0 ... 21000 Hz
Bandwidth [DC] 6 ... 21000 Hz
Weighting OFF
AF Channel Two
Default Settings ☑
Bandpass fixed
Bandwidth [AC] 0 ... 21000 Hz
Bandwidth [DC] 6 . 21000 Hz
Weighting OFF

Fig. 4-45 Multitone Configuration – Filter

Default All Settings The *Default All Settings* switch assigns default values to all fields in the *Filter* tab (the default values are quoted in the command description in chapter 6 of this manual). Two additional default switches reset all *AF Channel One* or all *AF Channel Two* settings, respectively.

Remote control

```
DEFault:MULTitone:FILTer ON | OFF
DEFault:MULTitone:AFxChannel:FILTer ON | OFF (x = 1,2)
```

AF Channel One The table section *AF Channel One* defines the input path for the *Multitone* measurement. The following settings are provided:

Band pass	Selection of the bandwidth of the CMU's audio band pass. A separate band pass can be selected for AC coupling and DC coupling.
Weighting	Use of a C-message weighted filter *(C-Message)*, a *CCITT* weighting filter or none of these filters *(OFF)*.

The CMU provides a broad selection of bandwidths with lower cutoff frequencies between 0 Hz and 300 Hz and upper cutoff frequencies between 250 Hz and 21 kHz (see command description in Chapter 6).

Note: *If the AF Path Coupling is set to DC (see section Measurement Control (Multitone Configuration – Control) on page 4.89), the audio analyzer receives the complete AF input signal including a possible DC component. To avoid measurement inaccuracies, a band pass with a lower cutoff ≥ 6 Hz must be used.*

Remote control

```
CONFigure:MULTitone:AFxChannel:FILTer:BPASs:DCCoupling
               <Bandwidth>
CONFigure:MULTitone:AFxChannel:FILTer:BPASs:ACCoupling
               <Bandwidth>
CONFigure:MULTitone:AFxChannel:FILTer:BPASs:WEIGhting
               CME | CCI | OFF  (x = 1,2)
```

I/Q and IF Interface (Option CMU-B17)

Option CMU-B17 provides separate access to the I/Q and IF signals in the CMU200 receiver (RX) and transmitter (TX) paths. The functionality is applicable in conjunction with the *RF* function group (see section *I/Q-IF Interface (Connection Control – I/Q-IF) REFFORMATVERBINDEN*on p. 4.74 ff.) and with a wide range of network options in *Signalling* as well as in *Non Signalling* test modes (see separate manuals for network options). The insertion of option CMU-B17 in bypass mode does not cause any influence on signals; i.e. the additional insertion loss caused by option CMU-B17 will be corrected during the mandatory calibration procedure after installation.

Block diagram The diagram below shows the possible signal paths and the input and output connectors related to option CMU-B17. The position of the connectors on the rear panel is shown in Chapter 1; for the technical specifications and the pin assignment refer to Chapter 8.

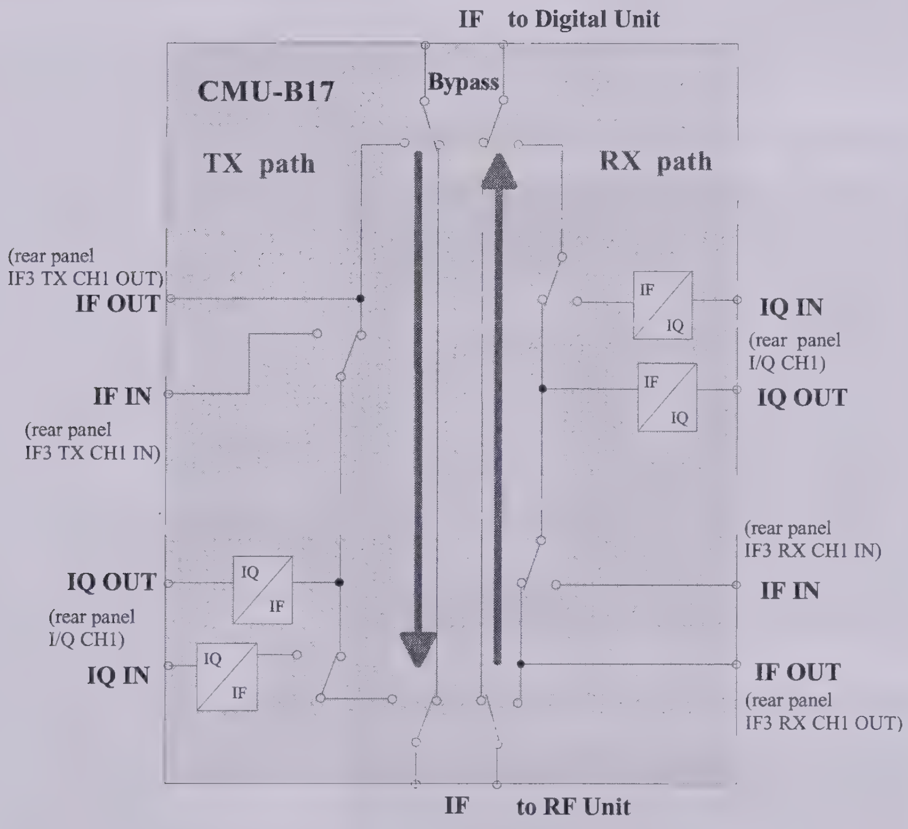

IF to Digital Unit
CMU-B17
Bypass
TX path
RX path
(rear panel IF3 TX CH1 OUT)
IF OUT
IF IN
(rear panel IF3 TX CH1 IN)
IQ OUT
(rear panel I/Q CH1)
IQ IN
IQ
IF
IQ IN
(rear panel I/Q CH1)
IQ OUT
(rear panel IF3 RX CH1 IN)
IF IN
IF OUT
(rear panel IF3 RX CH1 OUT)
IF to RF Unit

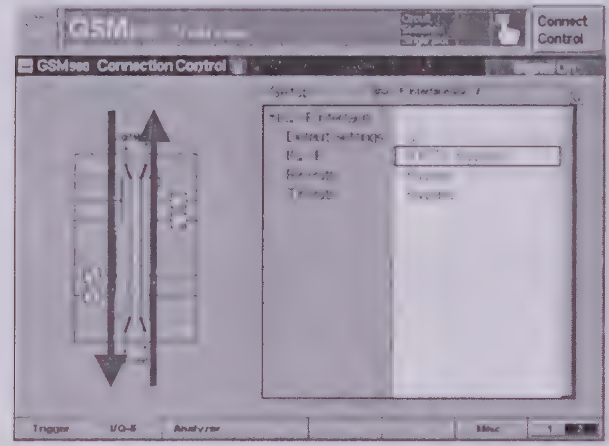
Fig. 4-46 I/Q-IF Interface

I/Q-IF Test Scenarios

A short overview of test scenarios with the necessary RX and TX path settings is given in *Table 4-1* on p. 4.75. The following examples illustrate the functionality in more detail.

The list of scenarios is not necessarily complete: Depending on the application, it is possible to define customized, *User defined* test scenarios.

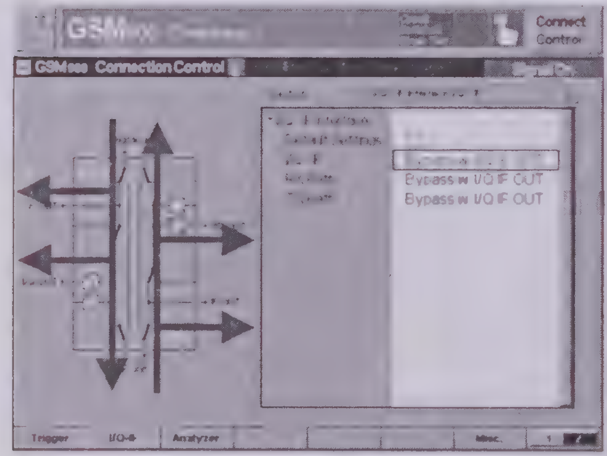
1. Default setting: Bypass mode for RF tests with maximum accuracy


GSM
Connect Control
GSM900 Connection Control
Trigger
I/Q-IF
Analyzer
Misc.
1

The path loss due to the inserted board CMU-B17 will be corrected automatically during the mandatory calibration procedure after installation of the option.

The option has no influence on transmitted and received signals.

2. Scenarios for I/Q-IF signal monitoring

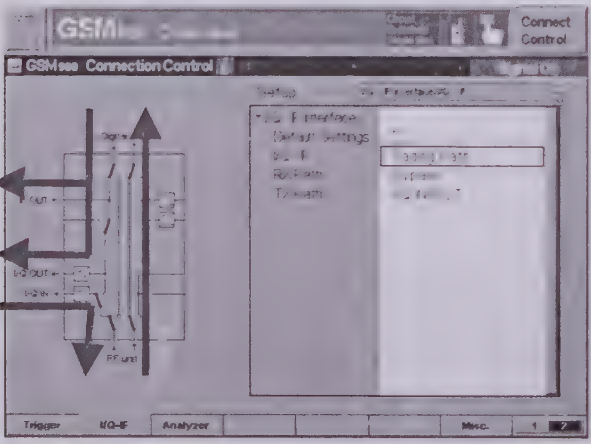

GSM
Connect Control
GSM900 Connection Control
Bypass w I/Q IF OUT
Bypass w I/Q IF OUT
Trigger
I/Q-IF
Analyzer
Misc.
1

Monitoring of uplink and downlink signals via IF or I/Q outputs possible.

The insertion loss of option CMU-B17 will be corrected during the calibration procedure.

This mode can be used for fading applications.

3. Interruption of I/Q or IF signal paths for external signal processing

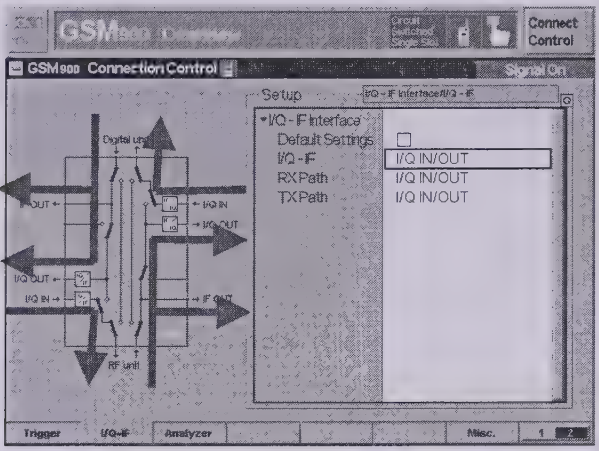

GSM
Connect Control
GSM900 Connection Control
I/Q OUT
I/Q IN
RF unit
Trigger
I/Q-IF
Analyzer
Misc.
1

Fading Path scenario:

The *Fading Path* scenario can be used for connecting an external baseband-fading simulator (pls. see next chapter, CMU200 and ABFS).

The transmitted signal can be routed to the fading simulator via IF or IQ outputs.

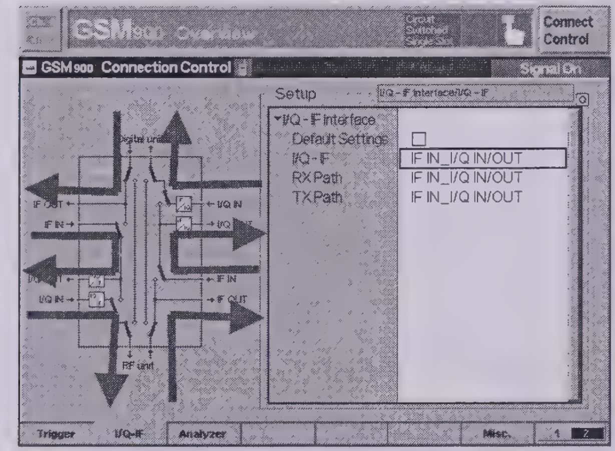
Additionally it is possible to return the faded signal via IQ input.


GSM900 Overview
Circuit Switched Single Slot
Connect Control
GSM900 Connection Control
Signal On
Digital unit
IF OUT
I/Q IN
I/Q OUT
I/Q OUT
I/Q IN
IF OUT
RF unit
Trigger
I/Q-IF
Analyzer
Misc.
1
2

Setup I/Q - IF Interface/I/Q - IF

- I/Q - IF Interface
  - Default Settings ☐
  - I/Q - IF: I/Q IN/OUT
  - RX Path: I/Q IN/OUT
  - TX Path: I/Q IN/OUT

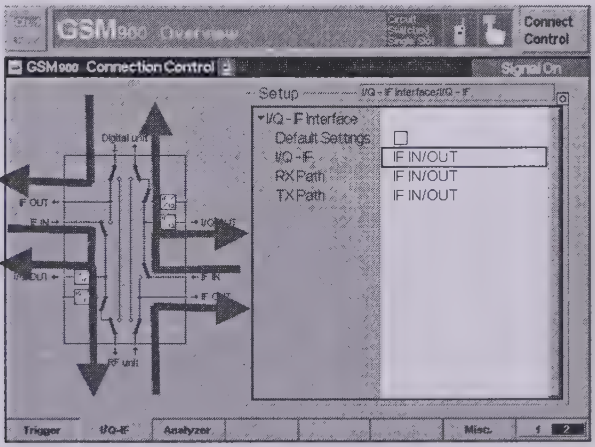
I/Q IN/OUT scenario


GSM900 Overview
Circuit Switched Single Slot
Connect Control
GSM900 Connection Control
Signal On
Digital unit
IF OUT
IF IN
I/Q IN
I/Q OUT
I/Q OUT
I/Q IN
IF IN
IF OUT
RF unit
Trigger
I/Q-IF
Analyzer
Misc.
1
2

Setup I/Q - IF Interface/I/Q - IF

- I/Q - IF Interface
  - Default Settings ☐
  - I/Q - IF: IF IN_I/Q IN/OUT
  - RX Path: IF IN_I/Q IN/OUT
  - TX Path: IF IN_I/Q IN/OUT

IF IN_I/Q IN/OUT scenario


GSM900 Overview
Circuit Switched Single Slot
Connect Control
GSM900 Connection Control
Signal On
Digital unit
IF OUT
IF IN
I/Q OUT
I/Q OUT
IF IN
IF OUT
RF unit
Trigger
I/Q-IF
Analyzer
Misc.
1
2

Setup I/Q - IF Interface/I/Q - IF

- I/Q - IF Interface
  - Default Settings ☐
  - I/Q - IF: IF IN/OUT
  - RX Path: IF IN/OUT
  - TX Path: IF IN/OUT

IF IN/OUT scenario

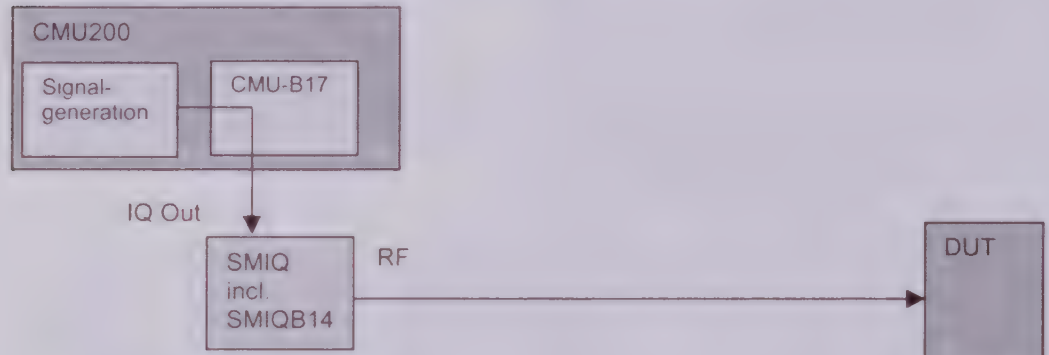
Application Examples

The following section is intended as a short introduction to possible applications of option CMU-B17. For detailed information refer to the relevant application notes.

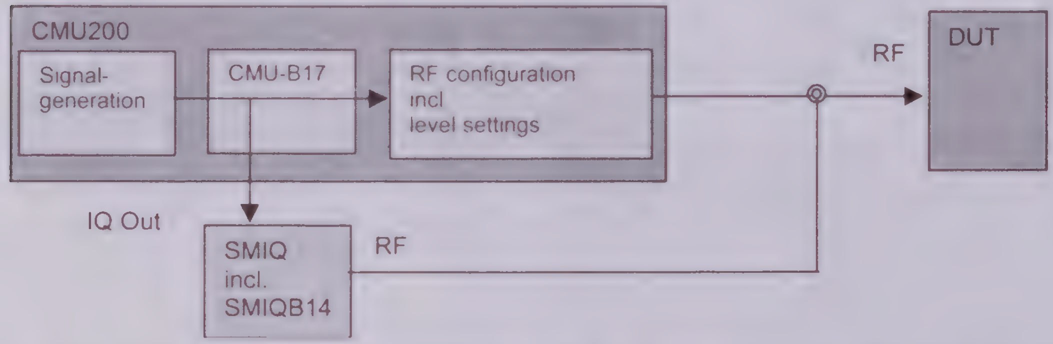
Bit Error Rate Measurements on Digital Receivers under Fading Conditions

1. CMU 200 / CMU-B17 in combination with SMIQ / SMIQ-B14

IQ/IF scenario: *Fading Path* or *Bypass w. I/Q IF OUT*


CMU200
Signal-generation
CMU-B17
IQ Out
SMIQ incl. SMIQB14
RF
DUT

IQ/IF scenario: *Bypass w I/Q IF OUT*

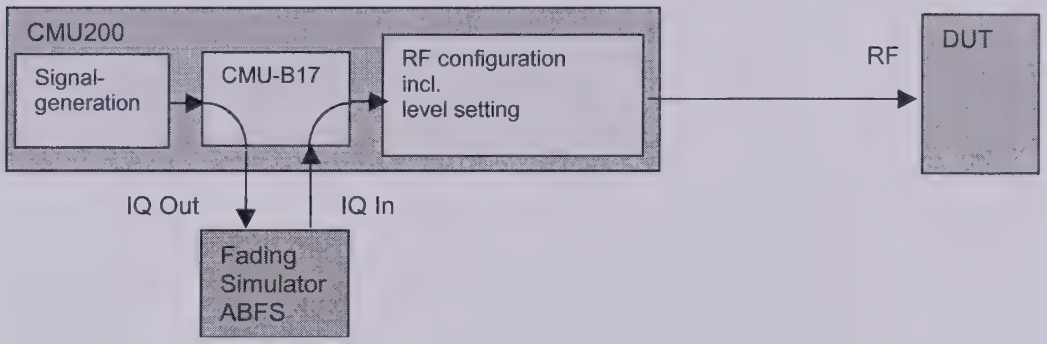

CMU200
Signal-generation
CMU-B17
RF configuration incl level settings
RF
DUT
IQ Out
SMIQ incl. SMIQB14
RF

The CMU incl. option CMU-B17 in combination with R&S signal generator SMIQ incl. IQ fading simulator option SMIQB14 can be used for receiver Bit Error Rate tests under fading conditions. The IQ output of CMU-B17 transmitter (TX) path feeds the signal into SMIQ's IQ input. The SMIQ forwards the faded RF signal directly to the receiver (RX) of the DUT. The illustrated test setups depend on the test scenario selected on option CMU-B17.

For more information please refer to R&S application note 1MA07_0E: *SMIQ as Fading Simulator for External Signals*.

2. CMU 200 / CMU-B17 in combination with fading simulator ABFS

IQ/IF scenario: *Fading Path*


CMU200
Signal-generation
CMU-B17
RF configuration incl. level setting
RF
DUT
IQ Out
IQ In
Fading Simulator ABFS

The CMU 200 incl. option CMU-B17 can be used in combination with the IQ fading simulator R&S ABFS for receiver tests under fading conditions. In this case the signal is routed to the DUT via the CMU's RF interface.

Additional information for GSM:

To avoid unwanted influences on the fading profile it is highly recommended:
To set all timeslots to the same level.

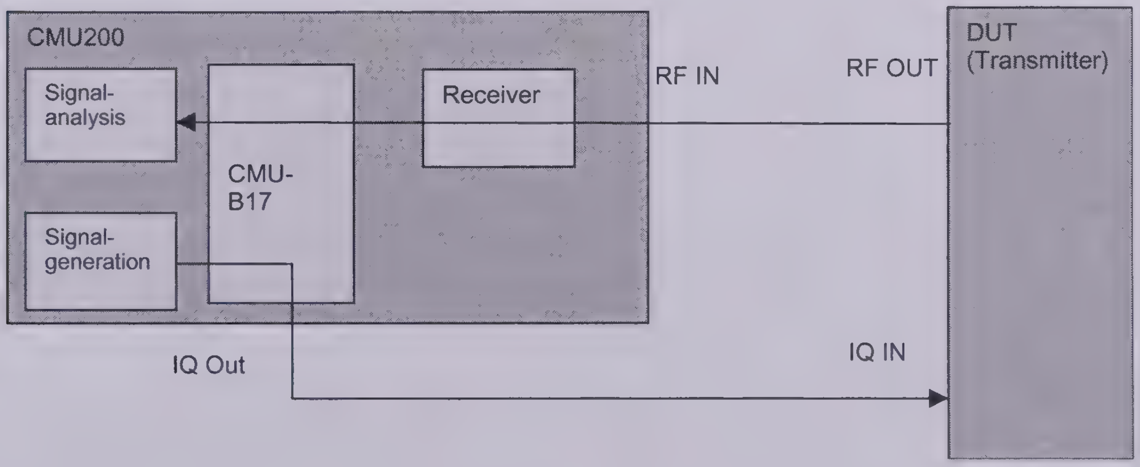
To configure the TX signal of the CMU with the same RF frequencies and RF levels for both TCH and BCCH.

To switch hopping off.

CMU200 as I/Q Generator and RF Analyzer

Another important application is the generation of IQ signals meeting the relevant standards. It is possible to generate complex signals that may even originate from a real signalling sequence. Most mobile radio chipsets comprise an RF chip and a baseband chip that communicate with each other via an analog IQ interface. The CMU-B17 IQ-interface can then be used to access the two chips. In mobile radio development, different teams are often required for this purpose and the new testing feature via the IQ interfaces allows development work to be divided in space and time.

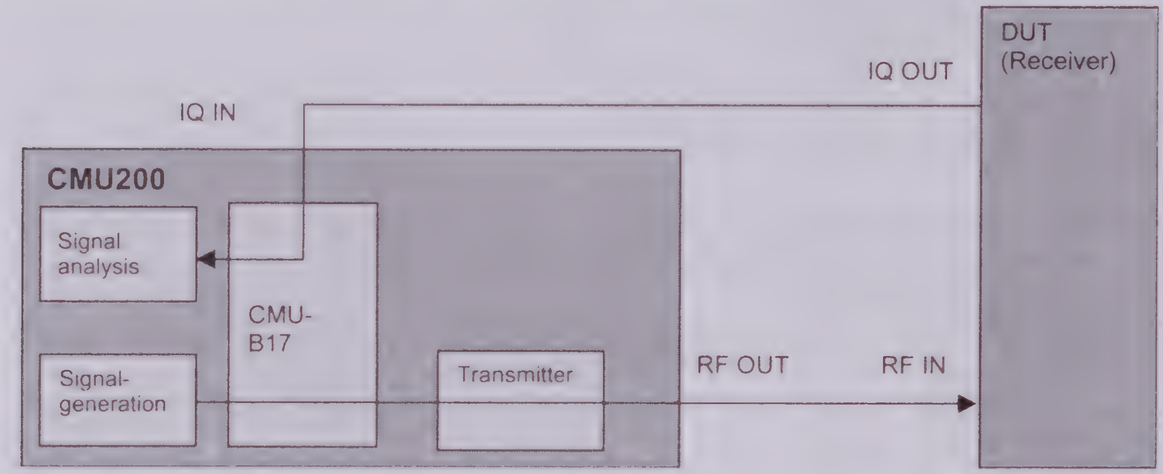
IQ/IF scenario: *Bypass w. I/Q IF OUT*


CMU200
Signal-analysis
CMU-B17
Receiver
Signal-generation
RF IN
RF OUT
DUT (Transmitter)
IQ Out
IQ IN

CMU200 as RF Generator and I/Q Analyzer

If IQ signals are applied to the receive section of the tester, signal analysis can be performed in the same manner as when analyzing an RF signal. In this test setup, a modulation analysis is useful since it assesses the quality of an IQ signal. The modulation analysis measures quantities such as the I/Q offset and I/Q imbalance, which are directly related to the I/Q signals. In addition, it provides more complex evaluations such as the error vector magnitude (EVM).

IQ/IF scenario: *User defined:* RX Path: *I/Q IN/OUT* TX Path: *Bypass*


DUT
(Receiver)
IQ OUT
IQ IN
CMU200
Signal analysis
CMU-B17
Signal-generation
Transmitter
RF OUT
RF IN

Contents

5 Remote Control – Basics 5.1

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  - Indications during Remote Control 5.3
  - Return to Manual Operation 5.4
  - Setting the Transmission Parameters (RS-232 interface) 5.5

GPIB Bus Messages 5.5
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5 Remote Control – Basics

This chapter provides:

- Instructions on how to set up the CMU for remote control operation.
- A general introduction to remote control of programmable instruments. This includes the description of the command structure and syntax according to the SCPI standard, the description of command execution and of the status registers.
- A comprehensive description of the CMU's remote control concept.

In section *Special Terms and Notation* on page 5.41, concepts and terms related to remote control of the CMU in particular are described. In Chapter 6, all *remote* control functions of the basic unit and of function groups *RF Analyzer* and *Audio* are described in detail. The commands for each function group and their parameters are listed according to their function and in alphabetical order in the command lists at the end of Chapter 6.

Program examples for the CMU can be found in Chapter 7.

Introduction

The instrument is equipped with an GPIB bus interface according to standard IEC 625.1/IEEE 488.1. The connectors are located at the rear of the instrument and permit to connect a controller for remote control.

This section assumes basic knowledge of GPIB bus programming and operation of the controller. A description of the interface commands can be obtained from the relevant manuals.

Not all of the commands supported by the instrument are taken from the SCPI standard (Standard Commands for Programmable Instruments), however, their syntax follows SCPI rules. The SCPI standard is based on standard IEEE 488.2 and aims at the standardization of device-specific commands, error handling and the status registers (see section *SCPI Introduction*).

The requirements of the SCPI standard placed on command syntax, error handling and configuration of the status registers are explained in detail in the following sections. Tables provide a fast overview of the bit assignment in the status registers. The tables are supplemented by a comprehensive description of the status registers.

Note: *In contrast to instruments with manual control, which are designed for maximum possible operating convenience, the priority of remote control is the "predictability" of the device status. This means that when incompatible settings are attempted, the command is ignored and the device status remains unchanged, i.e. other settings are not automatically adapted. Therefore, GPIB bus control programs should always define an initial device status (e.g. with the command *RST) and then implement the required settings.*

Operation via Remote Control

As any device, the CMU must be assigned a unique primary address in the range 0 to 30 decimal. In addition it uses extended addressing, i.e. a secondary address must be assigned to the individual function groups. Primary and secondary addresses can be defined in the *Remote* index card of the *Setup* menu (see Chapter 4) or via remote control.

Switchover to Remote Control

On power-on, the instrument is always in the manual operating state and can be operated via the front panel controls. The instrument is switched to remote control in the following cases:

With active GPIB bus	as soon as the Remote Enable (REN) GPIB line is asserted by the controller.
With active RS-232 interface	as soon as the instrument receives any characters via the interface.

Operation via the front panel is disabled. The instrument remains in the remote state until it is reset to the manual state via the front panel or via GPIB bus (see section *Return to Manual Operation)*.

Note: ***Local to remote transition and signalling states***

Switching from manual operation to remote control does usually not affect the device settings. However, if the CMU operates in a Non Signalling *test mode, all generators are switched off. In a* Signalling *mode, the current connection or call is dropped and the CMU returns to its default signalling state.*

To change this behavior and preserve the generator and signalling states in a local to remote transition, the command `SYSTem:GTRMode:COMPatible OFF` *can be used; see Chapter 6.*

Setting the Device Address

The GPIB address (primary address) of the instrument is factory-set to 20. It can be changed manually via the *Primary Address* softkey in the *Setup - Remote* menu or via GPIB bus. For remote control, addresses 0 through 30 are permissible.

In addition to the primary address, up to 30 secondary addresses can be assigned to the individual function groups and test modes. Secondary address 0 is reserved for the CMU base system. The other secondary addresses are set via the *Second. Address* softkey in the *Setup - Remote* menu or via remote control.

Note: *In the Setup – Remote menu, secondary addresses between 1 and 29 can be assigned. When using the National Instruments driver, add 96 to the secondary address. For example, specify a secondary address of 96 to access secondary address 0 on the instrument.*

Changing the addresses manually:

- ➢ Call *Setup - Remote* menu.
- ➢ Press *Primary Address* softkey. Enter desired address in the input field.
- ➢ Press *Second. Address* softkey. Use the rotary knob to select the list line with the desired address (numbers 1 to 29). Press ENTER to edit the line. From the popup window select the desired function group (use the rotary knob to change between the entries in the popup window). Confirm your selection and close the popup window using the ENTER key.
- ➢ Press the *ESCAPE* key to close the *Setup – Remote* menu.

Via GPIB bus interface:

- Use the `SYSTem:REMote:ADDRess:PRIMary <Addr_1>` command to define the GPIB bus address of the CMU.
- Use the `SYSTem:REMote:ADDRess:SECondary <Addr_2>,"<Fgroup>"` command to assign distinct secondary addresses to all function groups needed. The secondary address is transferred with each command (physical/hardware addressing, see program example in Chapter 7). Alternatively, software switchover with a command preceded by a secondary address and a semicolon is possible:

  `<Addr_2>;<Command>` (logical addressing of secondary address; use semicolon)

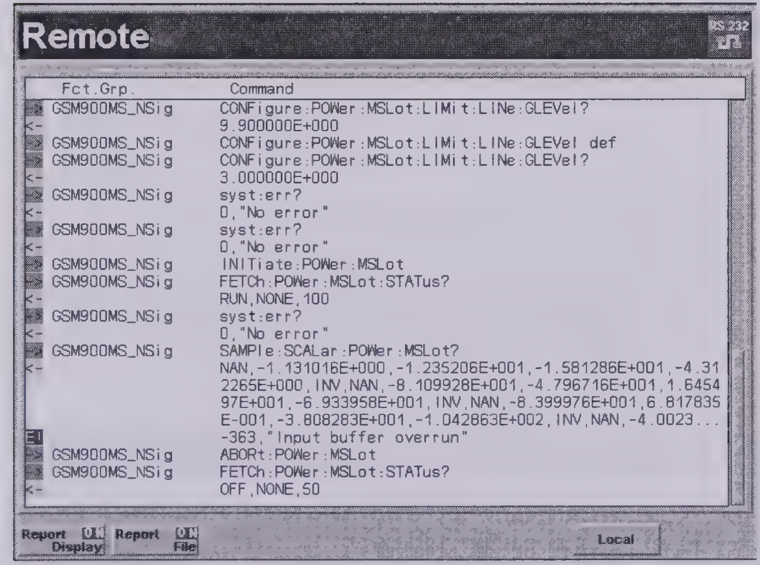
Via RS-232 interface:

- Use the `SYSTem:REMote:ADDRess:PRIMary <Addr_1>` command to define the GPIB bus address of the CMU.
- Use the `SYSTem:REMote:ADDRess:SECondary <Addr_2>,"<Fgroup>"` command to assign distinct secondary addresses to all function groups needed.
- Use the `*SEC <Addr_2>` command for a software switchover from one secondary address to another. Alternatively place `<Addr_2>;` in front of the command:

  `*SEC <Addr_2>` followed by `<Command>` is equivalent to `<Addr_2>;<Command>`, provided that secondary address `<Addr_2>` has been appropriately defined.

Indications during Remote Control

In the REMOTE state no menus but only the header REMOTE is indicated.



```
   Fct.Grp.          Command
-> GSM900MS_NSig     CONFigure:POWer:MSLot:LIMit:LINe:GLEVel?
<-                   9.900000E+000
-> GSM900MS_NSig     CONFigure:POWer:MSLot:LIMit:LINe:GLEVel def
-> GSM900MS_NSig     CONFigure:POWer:MSLot:LIMit:LINe:GLEVel?
<-                   3.000000E+000
-> GSM900MS_NSig     syst:err?
<-                   0,"No error"
-> GSM900MS_NSig     syst:err?
<-                   0,"No error"
-> GSM900MS_NSig     INITiate:POWer:MSLot
-> GSM900MS_NSig     FETCh:POWer:MSLot:STATus?
<-                   RUN,NONE,100
-> GSM900MS_NSig     syst:err?
<-                   0,"No error"
-> GSM900MS_NSig     SAMPle:SCALar:POWer:MSLot?
<-                   NAN,-1.131016E+000,-1.235206E+001,-1.581286E+001,-4.31
                     2265E+000,INV,NAN,-8.109928E+001,-4.796716E+001,1.6454
                     97E+001,-6.933958E+001,INV,NAN,-8.399976E+001,6.817835
                     E-001,-3.808283E+001,-1.042863E+002,INV,NAN,-4.0023...
E!                   -363,"Input buffer overrun"
-> GSM900MS_NSig     ABORt:POWer:MSLot
-> GSM900MS_NSig     FETCh:POWer:MSLot:STATus?
<-                   OFF,NONE,50
```

Fig. 5-1 Remote screen

Report Display

The *Report Display* hotkey can be activated (state *ON*, press the *ON/OFF* key) to display the input and output strings of the remote-control interface on the *Remote* screen. The remote display consists of three columns:

<Input/ouput>	Colored symbols for input (–>) to the CMU, output (<–) or error messages (E).
Fct. Grp.	Name of the addressed function group; see description of command `SYSTem:REMote:ADDRess:SECondary` in Chapter 6.
Command	Input command string, response/output string of the CMU or error message

Remote control
`TRACe:REMote:MODE:DISPlay ON | OFF`

Report File

The *Report File* hotkey can be activated (state *ON*, press the *ON/OFF* key) to write the input and output strings of the remote-control interface to a file named Remote.trc in the root directory of the internal hard disk (*INTERNAL* directory in the *Data* menu or directory C:\temp). The two softkeys *Report Display* and *Report File* may be active *(ON)* at the same time.

Remote control
`TRACe:REMote:MODE:FILE ON | OFF`

Local

The *Local* hotkey switches back to manual control. The current measurement and generator states and the current signalling state (if a *Signalling* test mode is active) are preserved; see also section *Return to Manual Operation* below.

Remote control
`GTL` interface message, included in the NI command `IBLOC (device%)`
(addressed command; see Chapter 8)
Equivalent CMU-specific command, also for operation via serial interface: `*GTL`

Return to Manual Operation

Return to manual operation can be initiated via the front panel or the GPIB bus.

Manually:

➢ Press any key at the front panel or press the *Local* hotkey in the *Remote* screen. The current measurement and generator states and the current signalling state (if a *Signalling* test mode is active) are preserved.

Note:

- *Before returning to manual control, command processing must be completed. If this is not the case, the CMU switches back to remote control immediately.*
- *Returning to manual control by pressing any front panel key can be disabled by the GPIB Local Lockout Message (LLO; see Chapter 8, Table* Universal Commands*), which is also included in the NI commands SetRWLS (Set Remote With Lockout State) or SendLLO. This prevents unintentional switchover, i.e. return to manual control is possible via the GPIB bus only. The CMU-specific command `*LLO TRUE` is equivalent to LLO.*
- *Returning to manual control via the front panel keys can be enabled again by deactivating the REN control line of the GPIB bus (see Chapter 8). The CMU-specific command `*LLO FALSe` also enables return to manual control.*

Via GPIB bus:	`...`
	`CALL IBLOC(device%)`
	`...`
		
		Set instrument to manual operation

Equivalent CMU-specific command, also for serial interface: `*GTL`

Target Menu

On switching over from remote to manual control, the CMU preserves the current measurement and generator states and the current signalling state (if a *Signalling* test mode is active). The instrument tries to open the menu that the user is likely to prefer, i.e. the measurement menu of the current, running measurement. If several measurements are running in parallel, the instrument applies the following selection rules to resolve the ambiguity and determine a preferred menu:

- The preferred menu must belong to a measurement that is in the *RUN* or *HLT* state (see section *Measurement Control Commands and States* on p. 5.28 ff.). *RDY* measurements and suppressed measurements are discarded.
- Measurement menus of the main application have the priority over configuration menus (e.g. for signalling and generators) and menus for additive applications (e.g. an *Audio* measurement that is performed in the context of a GSM-MS main application).
- Out of several running measurements of the same hierarchy level, the last one that was initiated (`INITiate:`... or `READ:`...`?`) is preferred.

If no measurement is in the *RUN* or *HLT* state, the last measurement that was aborted (`ABORt:`...) is preferred.

Setting the Transmission Parameters (RS-232 interface)

To ensure a correct data transmission, the parameters of the instrument and the controller must be set identically. The number of data and stop bits, the parity, baud rate and the handshake mode can be set independently for the two interfaces COM 1 and COM 2 in the *Setup - Comm.* menu:

- ➢ Open *Setup - Comm.* menu,
- ➢ Press one of the softkeys to select interface COM 1 or COM 2,
- ➢ Use the cursor keys and the rotary knob to select and change desired parameters,
- ➢ Terminate input using the *[ENTER]* key.

GPIB Bus Messages

The messages transferred via the data lines of the GPIB bus (see Chapter 8) can be divided into two groups:

- **interface messages**
- **device messages**

Interface Message

Interface messages are transferred on the data lines of the GPIB bus, the ATN control line being active. They are used for communication between controller and instrument and can only be sent by a computer which has the function of an GPIB bus controller.

Interface commands can be further subdivided into

- **universal commands**
- **addressed commands**

Universal commands act on all devices connected to the GPIB bus without previous addressing, addressed commands only act on devices previously addressed as listeners. The interface messages relevant to the instrument are listed in Chapter 8, section *Interface Messages*.

Device Messages (Commands and Device Responses)

Device messages are transferred via the data lines of the GPIB bus, the "ATN" control line not being active. The ASCII code is used. A distinction is made according to the direction in which device messages are transferred:

Commands are messages the controller sends to the instrument. They operate the device functions and request information. The commands are subdivided according to two criteria:

1. According to the effect they have on the instrument:

   Setting commands cause instrument settings such as a reset of the instrument or setting the output level to some value.

   Queries cause data to be provided for output on the GPIB bus, e.g. for identification of the device or polling the active input.

2. According to their definition in standard IEEE 488.2:

   Common Commands are exactly defined as to their function and notation in standard IEEE 488.2. They refer to functions such as management of the standardized status registers, reset and selftest.

   Device-specific Commands refer to functions depending on the features of the instrument such as frequency setting. A majority of these commands has also been standardized by the SCPI committee (cf. section *SCPI Introduction*).

Device responses are messages the instrument sends to the controller after a query. They can contain measurement results, instrument settings and information on the instrument status (cf. section 3.5.4).

Structure and syntax of the device messages are described in the next section. In Chapter 6 all commands are listed and explained in detail.

Structure and Syntax of Device Messages

SCPI Introduction

Not all of the commands supported by the instrument are taken from the SCPI standard (Standard Commands for Programmable Instruments), however, their syntax follows SCPI rules. All information given in this section and all the command examples apply to the CMU.

SCPI (Standard Commands for Programmable Instruments) describes a standard command set for programming instruments, irrespective of the type of instrument or manufacturer. The goal of the SCPI consortium is to standardize the device-specific commands to a large extent. For this purpose, a model was developed which defines the same functions inside a device or for different devices. Command systems were generated which are assigned to these functions. Thus it is possible to address the same functions with identical commands. The command systems are of a hierarchical structure. *Fig. 5-2* illustrates this tree structure using a section of command system SOURce, which operates the signal sources of the devices. The other examples concerning syntax and structure of the commands are derived from this command system.

SCPI is based on standard IEEE 488.2, i.e. it uses the same syntactic basic elements as well as the common commands defined in this standard. Part of the syntax of the device responses is defined with greater restrictions than in standard IEEE 488.2 (see section *Responses to Queries)*.

Command Structure

The commands consist of a so-called header and, in most cases, one or more parameters. Header and parameter are separated by a "white space" (ASCII code 0 to 9, 11 to 32 decimal, e.g. blank). The headers may consist of several key words. Queries are formed by directly appending a question mark to the header.

Common Commands

Common (=device-independent) commands consist of a header preceded by an asterisk "*" and eventually one or several parameters.

Examples:

`*RST`	RESET, resets the instrument.
`*ESE 253`	EVENT STATUS ENABLE, sets the bits of the event status enable registers.
`*ESR?`	EVENT STATUS QUERY, queries the contents of the event status register.

Device-specific commands

Hierarchy: Device-specific commands are of hierarchical structure (see *Fig. 5-2*). The different levels are represented by combined headers. Headers of the highest level (root level) have only one key word. This key word denotes a complete command system.

Example:

`SOURce` This key word denotes the command system `SOURce`.

For commands of lower levels, the complete path has to be specified, starting on the left with the highest level, the individual key words being separated by a colon ":".

Example:

`SOURce:RFGenerator:FHOPping:STATe ON`

This command is located on the fourth level of the SENse system. It switches on frequency hopping for the RF generator.

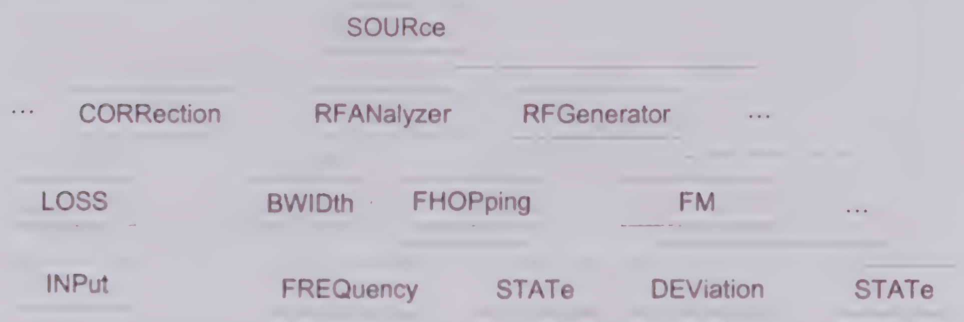


Fig. 5-2 Example for the tree structure of the SCPI command systems; the [illegible] system

Multiple key words

Some key words occur on several levels within one command system. Their effect depends on the structure of the command, i. e. on the position in the command header they are inserted in.

Example: `SOURce:RFGenerator:FHOPping:STATe ON`

This command contains the key word `SOURce` in the first command level. It switches on frequency hopping for the RF generator.

`TRIGger:SOURce EXTern`

This command contains the key word `SOURce` in the second command level. It defines the trigger source "external trigger".

Optional key words:

Some command systems permit certain key words to be optionally inserted into the header or omitted. These key words are marked by square brackets in this manual. The full command length must be recognized by the instrument for reasons of compatibility with the SCPI standard. Some commands are considerably shortened by omitting optional key words.

Example: `TRIGger[:SEQuence]:SOURce EXTern`

This command defines the trigger source "external trigger". The following command has the same effect:

`TRIGger:SOURce EXTern`

Note: *An optional key word must not be omitted if its effect is additionally specified by a numeric suffix.*

Long and short form:

The key words feature a long form and a short form. Either the short form or the long form can be entered, other abbreviations are not permissible.

Example:

```
TRIGger:SOURce EXTern
TRIG:SOUR EXT
```

Note: *The short form is marked by upper-case letters, the long form corresponds to the complete word. Upper-case and lower-case notation only serves to distinguish the two forms in the manual, the instrument itself does not distinguish upper-case and lower-case letters.*

Parameters: Parameters must be separated from the header by a "white space". If several parameters are specified in a command, they are separated by a comma ",". For a description of the types of parameter, refer to section *Parameters* on page 5.10.

Example:

```
CONFigure:POWer:CONTrol SCALar,100
```

This command defines the type of measured values in a power measurement and the number of samples/bursts forming a statistics cycle.

Numeric suffix: If a device features several functions or features of the same kind, e.g. several inputs, the desired function can be selected by a suffix added to the command. Entries without suffix are interpreted like entries with the suffix 1.

Example:

```
SOURce:CORRection:LOSS:INPut2 10dB
```

This command defines the external attenuation at the input connector RF 2

Structure of a Command Line

A command line may consist of one or several commands. It is terminated by a <New Line>, a <New Line> with EOI or an EOI together with the last data byte. Visual BASIC automatically produces an EOI together with the last data byte.

Several commands in a command line must be separated by a semicolon ";". If the next command belongs to a different command system, the semicolon is followed by a colon.

Example:

```
CALL IBWRT(device%, "TRIGger:SOURce EXTern;:FETch:POWer:STATus?")
```

This command line contains two commands. The first command belongs to the `TRIGger` system and defines the trigger source (external trigger). The second command belongs to the `FETCh` system and returns the status of the power measurement.

If the successive commands belong to the same system, having one or several levels in common, the command line can be abbreviated. To this end, the second command after the semicolon starts with the level that lies below the common levels (see also Fig. 5.1). The colon following the semicolon must be omitted in this case.

Example:

```
CALL IBWRT(device%, "TRIG:SOUR EXT;:TRIG:THR LOW")
```

This command line is represented in its full length and contains two commands separated from each other by the semicolon. Both commands are part of the `TRIGger` command system, i.e. they have one level in common.
When abbreviating the command line, the second command begins with the level below `TRIG`. The colon after the semicolon is omitted.

The abbreviated form of the command line reads as follows:

```
CALL IBWRT(device%, "TRIG:SOUR EXT;THR LOW")
```

However, a new command line always begins with the complete path.

Example:
```
CALL IBWRT(device%, "TRIG:SOUR EXT ")
CALL IBWRT(device%, "TRIG:THR LOW ")
```

Responses to Queries

A query is defined for each setting command unless explicitly specified otherwise. It is formed by adding a question mark to the associated setting command. According to SCPI, the responses to queries are partly subject to stricter rules than in standard IEEE 488.2.

1. The requested parameter is transmitted without header.
   Example: `TRIGger:THReshold?` Response: `LOW`
2. Maximum values, minimum values and all further quantities, which are requested via a special text parameter are returned as numerical values
   Example: `CONFigure:POWer:CONTrol:REPetition? MAX` Response: `10000`
3. Numerical values are output without a unit. Physical quantities are referred to the basic units or to the units set using the Unit command.
   Example: `SENSe:SPECtrum:FREQuency:STARt?` Response: `1E6` for 1 MHz
4. Boolean values are returned as 0 (for OFF) and 1 (for ON).
   Example: `SOURce:DM:CLOCk:STATe?` Response: `1`
5. Text (character data) is returned in a short form (see also next section).
   Example: `FETCh:SPECtrum:STATus?` Response: `ERR`

Parameters

Most commands require a parameter to be specified. The parameters must be separated from the header by a "white space". Permissible parameters are numerical values, Boolean parameters, text, character strings and block data. The type of parameter required for the respective command and the permissible range of values are specified in the command description.

Numerical values

Numerical values can be entered in any form, i.e. with sign, decimal point and exponent. Values exceeding the resolution of the instrument are rounded up or down. The mantissa may comprise up to 255 characters, the values must be in the value range –9.9E37 to 9.9E37. The exponent is introduced by an "E" or "e". Entry of the exponent alone is not allowed. In the case of physical quantities, the unit can be entered. Permissible unit prefixes are G (giga), MA (mega), MOHM and MHZ are also permissible), K (kilo), M (milli), U (micro) and N (nano). If the unit is missing, the basic unit is used.

Example: `SENS:SPEC:FREQ:STOP 1.5GHz` is equivalent to `SENS:SPEC:FREQ:STOP 1.5E9`

Special numerical values

The texts MINimum, MAXimum, DEFault, UP and DOWN are interpreted as special numerical values.

In the case of a query, the associated numerical value is provided.

Example: Setting command: `CONF:POW:CONT:REP MAXimum`
Query: `CONF:POW:CONT:REP?`
Response: `100`

MIN/MAX MINimum and MAXimum denote the minimum and maximum value.

DEF — DEFault denotes a preset value. This value conforms to the default setting, as it is called by the *RST command.

INF/NINF — INFinity, Negative INFinity (NINF) represent the numerical values -9.9E37 or 9.9E37, respectively. INF and NINF are only sent as device responses.

NAN — Not a Number (NAN) represents the value 9.91E37. NAN is only sent as device response. This value is not defined. Possible causes are division by zero, subtraction or addition of infinite and the representation of missing values.

Boolean Parameters

Boolean parameters represent two states. The ON state (logically true) is represented by ON or a numerical value unequal to 0. The OFF state (logically untrue) is represented by OFF or the numerical value 0. ON or OFF is provided in a query.

Example: Setting command: `SOURce:DM:CLOCk:STATe ON`
Query: `SOURce:DM:CLOCk:STATe?`
Response: `ON`

Text

Text parameters observe the syntactic rules for key words, i.e. they can be entered using a short or long form. Like any parameter, they have to be separated from the header by a white space. In the case of a query, the short form of the text is provided.

Example: Setting command: `TRIGger:SOURce EXTern`
Query: `TRIGger:SOURce?` Response: `EXT`

Strings

Strings must always be entered within quotation marks (' or ").

Example: `:SYST:REM:ADDR:SEC 1,"GSM900MS_NSig"` or
`:SYST:REM:ADDR:SEC 1,'GSM900MS_Nsig'`

Block data

Block data are a transmission format which is suitable for the transmission of large amounts of data. A command using a block data parameter with definite length has the following structure:

Example: `:HEADer:HEADer #45168xxxxxxxx`

The double dagger # introduces the data block. The next number indicates how many of the following digits describe the length of the data block. In the example the 4 following digits indicate the length to be 5168 bytes. The data bytes follow. During the transmission of these data bytes all End or other control signs are ignored until all bytes are transmitted.

A #0 combination introduces a data block of indefinite length. The use of the indefinite format requires a NL^END message to terminate the data block. This format is useful when the length of the transmission is not known or if speed or other considerations prevent segmentation of the data into blocks of definite length.

Overview of Syntax Elements

The following survey offers an overview of the syntax elements.

:	The colon separates the key words of a command. In a command line the separating semicolon marks the uppermost command level.
;	The semicolon separates two commands of a command line. It does not alter the path.
,	The comma separates several parameters of a command.
?	The question mark forms a query.
*	The asterisk marks a common command.
"	Quotation marks introduce a string and terminate it.
#	The double dagger # introduces binary, octal, hexadecimal and block data. Binary: #B10110 Octal: #O7612 Hexa: #HF3A7 Block: #21313...
	A "white space" (ASCII-Code 0 to 9, 11 to 32 decimal, e.g. blank) separates header and parameter.

Instrument Model and Command Processing

The block diagram in figure *Fig. 5-3* shows how GPIB bus commands are serviced in the instrument. The individual components work independently and simultaneously. They communicate with each other by means of so-called "messages".

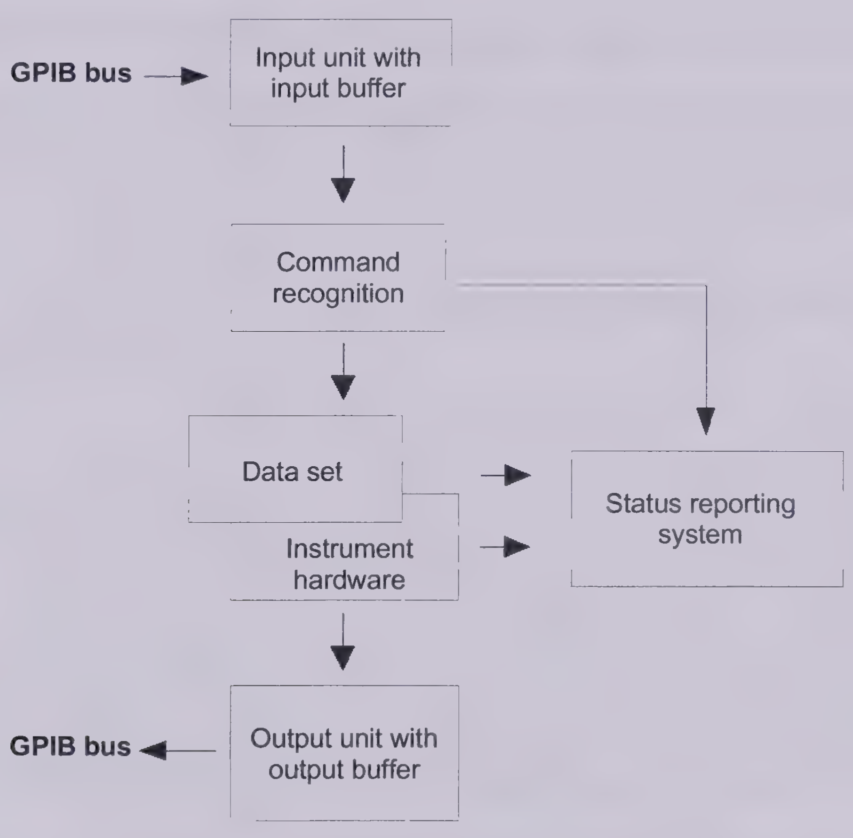

GPIB bus
Input unit with input buffer
Command recognition
Data set
Instrument hardware
Status reporting system
GPIB bus
Output unit with output buffer

Fig. 5-3 Instrument model in the case of remote control via GPIB bus

Input Unit

The input unit receives commands character by character from the GPIB bus and collects them in the input buffer. The input unit sends a message to the command recognition as soon as the input buffer is full or as soon as it receives a delimiter, <PROGRAM MESSAGE TERMINATOR>, as defined in IEEE 488.2, or the interface message DCL.

If the input buffer is full, the GPIB bus traffic is stopped and the data received up to then are processed. Subsequently the GPIB bus traffic is continued. If, however, the buffer is not yet full when receiving the delimiter, the input unit can already receive the next command during command recognition and execution. The receipt of a DCL clears the input buffer and immediately initiates a message to the command recognition.

Command Recognition

The command recognition analyses the data received from the input unit. It proceeds in the order in which it receives the data. Only a DCL is serviced with priority, a GET (Group Execute Trigger), e.g., is only executed after the commands received before. Each recognized command is immediately transmitted to the data set but not executed immediately.

Syntactical errors in the command are recognized here and transferred to the status reporting system. The rest of a command line after a syntax error is ignored.

If the command recognition recognizes a delimiter or a DCL, it requests the data set to set the commands in the instrument hardware as well. Subsequently it is immediately prepared to process commands again. This means for the command servicing that further commands can already be serviced while the hardware is still being set ("overlapping execution").

Data Set and Instrument Hardware

The expression "instrument hardware" denotes the part of the instrument fulfilling the actual instrument function - signal generation, measurement etc. The controller is not included.

The data set is a detailed software reproduction of the instrument hardware.

GPIB bus setting commands lead to an alteration in the data set. The data set management enters the new values (e.g. frequency) into the data set, however, only passes them on to the hardware when requested by the command recognition. As this is always only effected at the end of a command line, the order of the setting commands in the command line is not relevant.

The data are only checked for their compatibility among each other and with the instrument hardware immediately before they are transmitted to the instrument hardware. If the detection is made that execution is not possible, an "execution error" is signaled to the status reporting system. All alterations of the data set are canceled, the instrument hardware is not reset. Due to the delayed checking and hardware setting, however, impermissible instrument states can be set for a short period of time within one command line without this leading to an error message (example: simultaneous activation of FM and PM). At the end of the command line, however, a permissible instrument state must have been reached again.

Before passing on the data to the hardware, the settling bit in the STATus:OPERation register is set (cf. section *STATus:OPERation Register*). The hardware executes the settings and resets the bit again as soon as the new state has settled. This fact can be used to synchronize command servicing.

GPIB bus queries induce the data set management to send the desired data to the output unit.

Status Reporting System

The status reporting system collects information on the instrument state and makes it available to the output unit on request. The exact structure and function are described in section Status Reporting System on page 5.16.

Output Unit

The output unit collects the information requested by the controller, which it receives from the data set management. It processes it according to the SCPI rules and makes it available in the output buffer. If the information requested is longer, it is made available "in portions" without this being recognized by the controller.

If the instrument is addressed as a talker without the output buffer containing data or awaiting data from the data set management, the output unit sends error message "Query UNTERMINATED" to the status reporting system. No data are sent on the GPIB bus, the controller waits until it has reached its time limit. This behavior is specified by SCPI.

Command Sequence and Command Synchronization

What was said above makes clear that overlapping execution is possible in principle for all commands. Equally, setting commands within one command line are not absolutely serviced in the order in which they have been received.

In order to make sure that commands are actually carried out in a certain order, each command must be sent in a separate command line, that is to say, with a separate IBWRT()-call.
In order to prevent an overlapping execution of commands, one of commands *OPC, *OPC? or *WAI must be used. All three commands cause a certain action only to be carried out after the hardware has been set and has settled. By a suitable programming, the controller can be forced to wait for the respective action to occur (cf. *Table 5-1*).

Table 5-1 Synchronization with *OPC, *OPC? and *WAI

Command	**Action after the hardware has settled**	**Programming the controller**
*OPC	Setting the operation-complete bit in the ESR	- Setting bit 0 in the ESE - Setting bit 5 in the SRE - Waiting for service request (SRQ)
*OPC?	Writing a "1" into the output buffer	Addressing the instrument as a talker
*WAI	Executing the next command Note: The GPIB bus handshake is not stopped	Sending the next command

Status Reporting System

The status reporting system (cf. Fig. 5-5) stores all information on the present operating state of the instrument, and on errors which have occurred. This information is stored in the status registers and in the error queue. The status registers and the error queue can be queried via GPIB bus.

The information is of a hierarchical structure. The register status byte (STB) defined in IEEE 488.2 and its associated mask register service request enable (SRE) form the uppermost level. The STB receives its information from the standard event status register (ESR) which is also defined in IEEE 488.2 with the associated mask register standard event status enable (ESE) and registers STATus:OPERation and STATus:QUEStionable which are defined by SCPI and contain detailed information on the instrument.

The IST flag ("Individual STatus") and the parallel poll enable register (PPE) allocated to it are also part of the status reporting system. The IST flag, like the SRQ, combines the entire instrument status in a single bit. The PPE fulfills an analog function for the IST flag as the SRE for the service request.

The output buffer contains the messages the instrument returns to the controller. It is not part of the status reporting system but determines the value of the MAV bit in the STB and thus is represented in *Fig. 5-5*.

Structure of an SCPI Status Register

Each standard SCPI register consists of 5 parts which each have a width of 16 bits and have different functions (cf. *Fig. 5-4*). The individual bits are independent of each other, i.e. each hardware status is assigned a bit number which is valid for all five parts. Bit 15 (the most significant bit) is set to zero for all parts. Thus the contents of the register parts can be processed by the controller as positive integer.

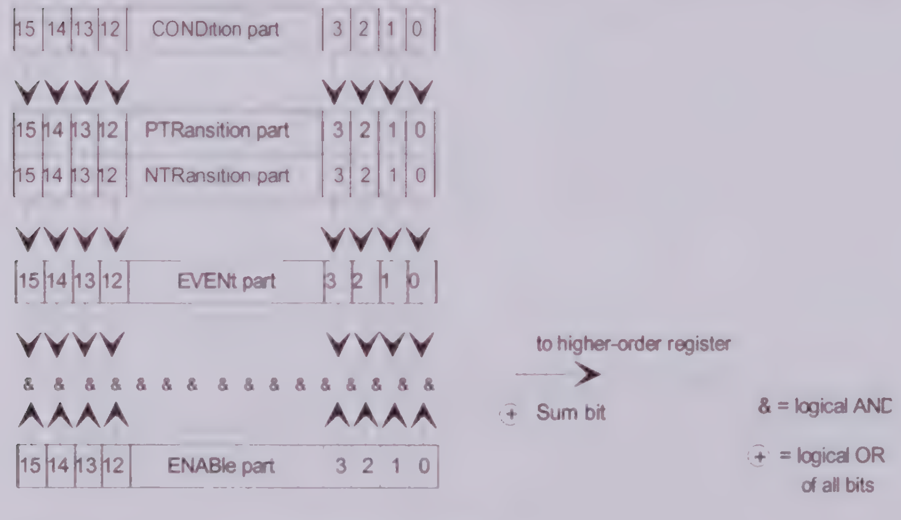

15 14 13 12 CONDition part 3 2 1 0
15 14 13 12 PTRansition part 3 2 1 0
15 14 13 12 NTRansition part 3 2 1 0
15 14 13 12 EVENt part 3 2 1 0
& & & & & & & & & & & & & & & &
15 14 13 12 ENABle part 3 2 1 0
to higher-order register
+ Sum bit
& = logical AND
+ = logical OR of all bits

Fig. 5-4 The status register model

CONDition part

The CONDition part is permanently overwritten by the hardware or the sum bit of the next lower register. Its contents always reflect the current instrument status. This register part can only be read, but not overwritten or cleared. Reading the CONDition register is nondestructive.

PTRansition part

The Positive-TRansition part acts as a transition filter. When a bit of the CONDition part is changed from 0 to 1, the associated PTR bit decides whether the EVENt bit is set to 1.
PTR bit =1: the EVENt bit is set.
PTR bit =0: the EVENt bit is not set.
This status register part can be overwritten and read at will. Reading the PTRansition register is nondestructive.

NTRansition part

The Negative-TRansition part also acts as a transition filter. When a bit of the CONDition part is changed from 1 to 0, the associated NTR bit decides whether the EVENt bit is set to 1.
NTR bit =1: the EVENt bit is set.
NTR bit =0: the EVENt bit is not set.
This part can be overwritten and read at will. Reading the PTRansition register is nondestructive.

With these two transition register parts the user can define which state transition of the condition part (none, 0 to 1, 1 to 0 or both) is stored in the EVENt part.

EVENt part

The EVENt part indicates whether an event has occurred since the last reading, it is the "memory" of the condition part. It only indicates events passed on by the transition filters. It is permanently updated by the instrument. This part can only be read by the user. Reading the register clears it. This part is often equated with the entire register.

The CMU implementation of the EVENt parts of all status registers differs from the SCPI specification: The bits in the EVENt part are directly set by the instrument as soon as the instrument state changes so that the setting condition becomes true. The CONDition, PTRansition, and NTRansition register parts are not needed. The EVENt part is cleared upon reading.

ENABle part

The ENABle part determines whether the associated EVENt bit contributes to the sum bit (cf. below). Each bit of the EVENt part is ANDed with the associated ENABle bit (symbol '&'). The results of all logical operations of this part are passed on to the sum bit via an OR function (symbol '+').
ENAB bit =0: the associated EVENt bit does not contribute to the sum bit
ENAB bit =1: if the associated EVENT bit is "1", the sum bit is set to "1" as well.
This part can be written into and read by the user at will. Its contents is not affected by reading.

Sum bit

As indicated above, the sum bit is obtained from the EVENt and ENABle part for each register. The result is then entered into a bit of the CONDition part of the higher-order register.
The instrument automatically generates the sum bit for each register. Thus an event, e.g. a PLL that has not locked, can lead to a service request throughout all levels of the hierarchy.

Note:

The service request enable register SRE defined in IEEE 488.2 can be taken as ENABle part of the STB if the STB is structured according to SCPI. By analogy, the ESE can be taken as the ENABle part of the ESR.

Overview of the Status Registers

Fig. 5-5 shows the status registers used in the CMU. The STATus:QUEStionable register is not used. In addition to the standard STATus:OPERation register, the CMU offers 30 independent STATus:OPERation:CMU:SUM1|2:CMU<nr> sub-registers (<nr>=1 ... 15).

Cascading registers

The hierarchical structure of the STATus:OPERation register was designed with the aim of reporting and specifying the events generated during different measurements independently. Each sub-register receives entries from a particular combination of a function group and signalling mode (e.g. *RF Non Signalling*, *GSM900-MS Signalling* etc.). The function groups and modes are identified by means of their secondary address, an integer number between 0 and 29. Secondary address 0 is reserved for the CMU base system. The remaining secondary addresses can be arbitrarily assigned or queried via the `SYSTem:REMote:ADDRess:SECondary` command (see Chapter 6). The assignment between sub-registers and secondary addresses is as follows:

Sub-register	Secondary Address	Sub-register	Secondary Address
STAT:OPER:CMU:SUM1:CMU1	0 (reserved for CMU base system)	STAT:OPER:CMU:SUM2:CMU1	15
...			...
STAT:OPER:CMU:SUM1:CMU15	14	STAT:OPER:CMU:SUM2:CMU15	29

Contents of the sub-registers

The higher-level STATus:OPERation registers summarize the sub-registers as shown in Fig. 5-5. E.g., if the corresponding ENABle bit is set, any EVENt reported in one of the STATus:OPERation:CMU:SUM1|2:CMU<nr> sub-registers sets the sum bit of the STATus:OPERation:CMU:SUM1|2 register to 1.

This means that the STATus:OPERation register indicates whether any event occurred, the lower-level STATus:OPERation:CMU:SUM1|2 registers indicate the function group and signalling mode in which the event occurred, the lowest-level STATus:OPERation:CMU:SUM1|2 registers indicate the nature of the individual events.

The meaning of the bits in function group *RF Non Signalling* is given below (see section STATus:OPERation Register 5.22). For other function groups refer to the relevant manuals.

Accessing the sub-registers

Every single status register can be configured and queried individually by means of the commands of the STATus:OPERation subsystem (see Chapter 6).

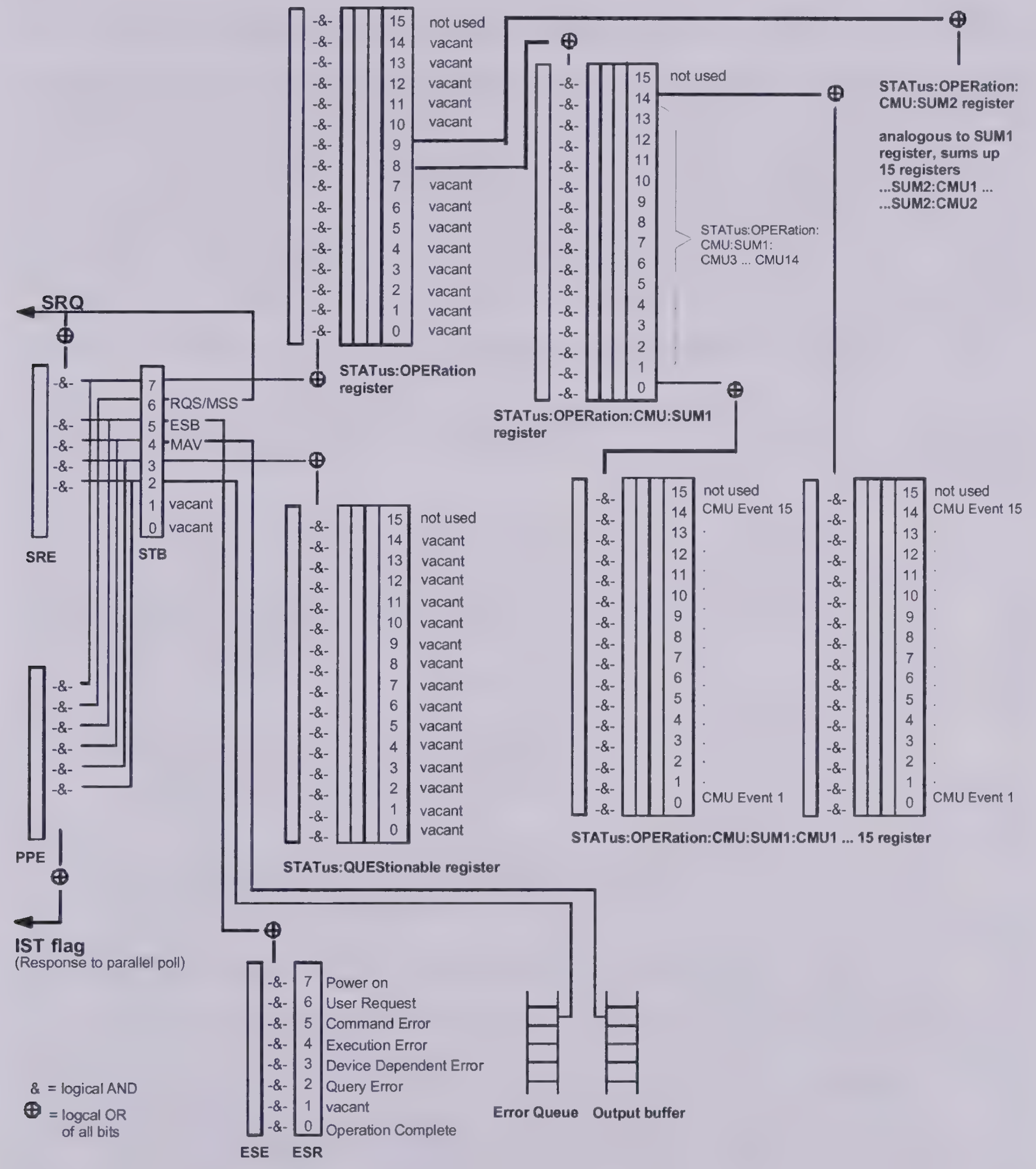

15 not used
14 vacant
13 vacant
12 vacant
11 vacant
10 vacant
9
8
7 vacant
6 vacant
5 vacant
4 vacant
3 vacant
2 vacant
1 vacant
0 vacant
-&-
STATus:OPERation register
STATus:OPERation:CMU:SUM1 register
15 not used
14
STATus:OPERation: CMU:SUM1: CMU3 ... CMU14
STATus:OPERation: CMU:SUM2 register
analogous to SUM1 register, sums up 15 registers ...SUM2:CMU1 ... ...SUM2:CMU2
SRQ
SRE
STB
7
6 RQS/MSS
5 ESB
4 MAV
3
2
1 vacant
0 vacant
PPE
IST flag
(Response to parallel poll)
STATus:QUEStionable register
15 not used
14 vacant
13 vacant
12 vacant
11 vacant
10 vacant
9 vacant
8 vacant
7 vacant
6 vacant
5 vacant
4 vacant
3 vacant
2 vacant
1 vacant
0 vacant
15 not used
14 CMU Event 15
0 CMU Event 1
STATus:OPERation:CMU:SUM1:CMU1 ... 15 register
7 Power on
6 User Request
5 Command Error
4 Execution Error
3 Device Dependent Error
2 Query Error
1 vacant
0 Operation Complete
ESE
ESR
Error Queue
Output buffer
& = logical AND
⊕ = logcal OR of all bits

Fig. 5-5 The status registers

Status Byte (STB) and Service Request Enable Register (SRE)

The STB is already defined in IEEE 488.2. It provides a rough overview of the instrument status by collecting the pieces of information of the lower registers. It can thus be compared with the CONDition part of an SCPI register and assumes the highest level within the SCPI hierarchy. A special feature is that bit 6 acts as the sum bit of the remaining bits of the status byte.

The STATUS BYTE is read out using the command "*STB?" or a serial poll.

The STB is linked to the SRE. The latter corresponds to the ENABle part of the SCPI registers in its function. Each bit of the STB is assigned a bit in the SRE. Bit 6 of the SRE is ignored. If a bit is set in the SRE and the associated bit in the STB changes from 0 to 1, a Service Request (SRQ) is generated on the GPIB bus, which triggers an interrupt in the controller if this is appropriately configured and can be further processed there.
The SRE can be set using command "*SRE" and read using "*SRE?".

Table 5-2 Meaning of the bits used in the status byte

Bit no	Meaning
2	**Error Queue not empty** The bit is set when an entry is made in the error queue. If this bit is enabled by the SRE, each entry of the error queue generates a Service Request. Thus an error can be recognized and specified in greater detail by polling the error queue. The poll provides an informative error message. This procedure is to be recommended since it considerably reduces the problems involved with GPIB bus control
3	**QUEStionable status sum bit** The bit is set if an EVENt bit is set in the QUEStionable status register and the associated ENABle bit is set to 1. A set bit indicates a questionable instrument status, which can be specified in greater detail by polling the QUEStionable status register.
4	**MAV-Bit** (Message AVailable) The bit is set if a message is available in the output buffer which can be read. This bit can be used to enable data to be automatically read from the instrument to the controller (cf. annex D, program examples).
5	**ESB bit** Sum bit of the event status register. It is set if one of the bits in the event status register is set and enabled in the event status enable register. Setting of this bit indicates a serious error which can be specified in greater detail by polling the event status register.
6	**MSS-Bit** (Master Status Summary bit) The bit is set if the instrument triggers a service request. This is the case if one of the other bits of this register is set together with its mask bit in the service request enable register SRE.
7	**OPERation status register sum bit** The bit is set if an EVENt bit is set in the OPERation status register and the associated ENABle bit is set to 1. A set bit indicates that the instrument is just performing an action. The type of action can be queried by polling the OPERation status register.

IST Flag and Parallel Poll Enable Register (PPE)

By analogy with the SRQ, the IST flag combines the entire status information in a single bit. It can be queried by means of a parallel poll (cf. Section *Parallel Poll* on page 5.25) or using the command "`*IST?`".

The parallel poll enable register (PPE) determines which bits of the STB contribute to the IST flag. The bits of the STB are ANDed with the corresponding bits of the PPE, with bit 6 being used as well in contrast to the SRE. The IST flag results from the ORing of all results. The PPE can be set using commands "*PRE" and read using command "`*PRE?`".

Event Status Register (ESR) and Event Status Enable Register (ESE)

The ESR is defined in IEEE 488.2. It can be compared with the EVENt part of an SCPI register. The event status register can be read out using command "`*ESR?`".
The ESE is the associated ENABle part. It can be set using the command "`*ESE`" and read using the command "`*ESE?`".

Table 5-3 Meaning of the bits used in the event status register

Bit No.	Meaning
0	**Operation Complete** This bit is set on receipt of the command *OPC exactly when all previous commands have been executed.
2	**Query Error** This bit is set if either the controller wants to read data from the instrument without having sent a query, or if it does not fetch requested data and sends new instructions to the instrument instead. The cause is often a query which is faulty and hence cannot be executed.
3	**Device-dependent Error** This bit is set if a device-dependent error occurs. An error message with a number between -300 and -399 or a positive error number, which denotes the error in greater detail, is entered into the error queue (cf. annex B, Error Messages).
4	**Execution Error** This bit is set if a received command is syntactically correct but cannot be performed for other reasons. An error message with a number between -200 and -300, which denotes the error in greater detail, is entered into the error queue (cf. annex B, Error Messages).
5	**Command Error** This bit is set if a command which is undefined or syntactically incorrect is received. An error message with a number between -100 and -200, which denotes the error in greater detail, is entered into the error queue (cf. annex B, Error Messages).
6	**User Request** This bit is not used in the CMU.
7	**Power On** (supply voltage on) This bit is set on switching on the instrument.

STATus:OPERation Register

The CMU offers 30 independent STATus:OPERation:CMU:SUM1|2:CMU<nr> sub-registers (<nr>=1 ... 15) which are implemented in hierarchical form. The bits of the 30 STATus:OPERation registers are set only after the registers are assigned to a function group and measurement mode (see p. 5.18).

In the EVENt part, the STATus:OPERation register contains information on which actions the instrument has executed since the last readout. All five parts of the registers can be read using one of the commands of the subsystem `STATus:OPERation:CMU:SUM1|2:CMU<nr>:...` . Moreover, the EVENt part can be enabled and read by means of the `STATus:OPERation:SYMBolic:...` commands, see section *Symbolic Status Event Register Evaluation* on page 5.25 ff.

The bit assignment for the CMU base system which is always assigned to the `...SUM1:CMU1` sub-register (secondary address 0) is as follows:

Table 5-4 Meaning of the bits used in the `STATus:OPERation:CMU:SUM1:CMU1` sub-register assigned to the CMU base system

Bit-No.	**Meaning**	**Symbol in** `STATus:OPERation:SYMBolic...`
4	**Measurement Result is Invalid** This bit is set if a measurement caused invalid results, e.g. because of no input signal was available (see also application example below and section *Retrieving Measurement Results* on p. 5.35 ff.).	**MINV**
6	**Reference Frequency Not Locked** This bit is set if synchronization to the reference frequency failed (e.g. because of a missing or faulty external reference frequency). The CMU checks the synchronization approx. once per second and updates the RFNL bit. Alternatively, the synchronization can be queried via `[SENSe:]SYNChronize:FREQuency:REFerence:LOCKed?` (see Chapter 6)	**RFNL**

For function group *RF Non Signalling*, the bit assignment is as follows:

Table 5-5 Meaning of the bits used in the `STATus:OPERation:CMU:SUM1|2:CMU<nr>` sub-register assigned to *RF Non Signalling*

Bit-No.	**Meaning**	**Symbol in** `STATus:OPERation:SYMBolic...`
0	**Overload** This bit is set if the currently used input connector is overloaded.	**IOV**
4	**Measurement Result is Invalid** This bit is set if a measurement caused invalid results, e.g. because no input signal was available (see also application example below and section *Retrieving Measurement Results* on p. 5.35 ff.).	**MINV**
11	**RF Input Overdriven** This bit is set if the RF input level at connector RF1, RF2 or RF 4 IN is larger than the specified *RF Max. Level* plus an appropriate margin.	**RFIO**

Bit-No.	Meaning	Symbol in `STATus:OPERation:SYMBolic...`
12	**RF Input Underdriven** This bit is set while the RF input level at connector RF1, RF2 or RF 4 IN falls below the measurement range controlled by the specified *RF Max. Level.*	**RFIU**

For optional function groups refer to the relevant manuals.

Application example (see also description of Winbatch tool in Chapter 7): The following command sequence shows how an event "Measurement Result is Invalid" is registered in the status reporting system and illustrates some of the tools that the CMU provides to monitor the instrument status.

...

`CMUBASE: *CLS`	Clear status reporting system.
`CMUBASE: TRACE:REMOTE:MODE:SRQ ON`	Include service requests sent by the CMU in the remote control report.
`CMUBASE: TRACE:REMOTE:MODE:DISPLAY ON`	Display remote report on screen.
`CMUBASE: *SRE 128`	Enable service request.
`CMUGSMNS: STAT:OPER:SYMB:ENAB MINV`	Enable event reporting for bit no. 4, MINV, in a different function group (GSMxxx-MS Non Signalling).
`CMUGSMNS: READ:SCAL:NPOW?`	Initiate a single-shot narrow-band power measurement using default settings and return results. In case of invalid measurement results (e.g. because no GSM input signal is applied to the input connectors of the CMU), a read symbol "S" for service request should appear on the screen.
`CMUBASE: STAT:OPER:EVEN:SADD?`	Check which function group reported an event. The query returns the GSM function group.
`CMUGSMNS: STAT:OPER:SYMB?`	Query events reported by the GSM function group: Bit MINV must be set

STATus:QUEStionable-Register

This register contains information on questionable instrument states. They can occur, e.g. if the instrument is operated outside its specified range. It can be queried using one of the commands "`:STATus :QUEStionable:CONDition?`" or "`:STATus:QUEStionable[:EVENt]?`".

The CMU does not use this register.

Application of the Status Reporting Systems

In order to effectively use the status reporting system, the information contained there must be transmitted to the controller and further processed there. There are several methods which are outlined in the following.

Service Request

Under certain circumstances, the instrument can send a service request (SRQ) to the controller. Usually this service request initiates an interrupt at the controller, to which the control program can react appropriately. As evident from Fig. 5-5, an SRQ is always initiated if one or several of bits 2, 3, 4, 5 or 7 of the status byte are set and enabled in the SRE. Each of these bits combines the information of a further register, the error queue or the output buffer. The corresponding setting of the ENABle parts of the status registers can achieve that arbitrary bits in an arbitrary status register initiate an SRQ. In order to use the possibilities of the service request effectively, all bits should be set to "1" in the enable registers SRE and ESE.

Examples (cf. Fig. 5-5):

Use command "`*OPC`" to generate an SRQ

- Set bit 0 in the ESE (Operation Complete)
- Set bit 5 in the SRE (ESB)

After its settings have been completed, the instrument generates an SRQ.

Indication of an event (e.g. overloading of used input connector) by means of an SRQ with the controller:

- Set bit 7 in the SRE (sum bit of the STATus:OPERation register)

The following steps depend on the secondary address (0 ≤ <SecAddr> < 29) assigned to the function group and signalling mode used.

0 ≤ <SecAddr> ≤ 14

- Set bit 8 in the STATus:OPERation:ENABle register.
- Set bit <SecAddr>-1 in the STATus:OPERation:CMU:SUM1:ENABle register
- Set bit 0 in the STATus:OPERation:CMU:SUM1:CMU <SecAddr>:ENABle register.

15 ≤ <SecAddr> ≤ 29

- Set bit 9 in the STATus:OPERation:ENABle register.
- Set bit <SecAddr>-16 in the STATus:OPERation:CMU:SUM2:ENABle register
- Set bit 0 in the STATus:OPERation:CMU:SUM2:CMU <SecAddr>:ENABle register.

When the event assigned to bit no. 0 of the STATus:OPERation:CMU:SUM1|2:CMU<SecAddr> register occurs (e.g. when the input connector is overloaded in function group *RF Non Signalling)* the instrument generates a SRQ.

The same procedure can be applied to find out which event caused an SRQ:

- `STB?`
- Query `STAT:OPER:EVENT?`
- Query `STAT:OPER:CMU:SUM1|2:EVENT?` (function group, signalling mode)
- Query `STAT:OPER:CMU:SUM1|2:CMU1...15:EVENT?` (measurement)

The SRQ is the only possibility for the instrument to become active on its own. Each controller program should set the instrument such that a service request is initiated in the case of malfunction. The program should react appropriately to the service request.

Symbolic Status Event Register Evaluation

The examples for status register handling given in section *Service Request* on p. 5.24 are based on a step-by-step evaluation of the `STATus:OPERation` register and its sub-registers. As a convenient alternative to this approach, the CMU provides commands for symbolic status event register evaluation. These commands are global (i.e. available in all function groups) and described in detail in Chapter 6. They organize and simplify the following actions:

`STATus:OPERation:EVENt:SADDress?`	Return the next secondary address and associated function group where an event was reported.
`STATus:OPERation:SYMBolic:ENABle` `<Event_1>[,<Event_2>,...<Event_15>]`	Enable the events of the parameter list up to the status byte, i.e. set the corresponding bits in the `STATus:OPERation:ENABle` register and in the sub-registers `STATus:OPERation:CMU:SUM1|2:ENABle` and `STATus:OPERation:CMU:SUM1|2:CMU <SecAddr>:ENABle` so that the events are reported in the status byte. <SecAddr> denotes the current secondary address, see also example in section *Service Request* on p. 5.24.
`STATus:OPERation:SYMBolic[:EVENt]?`	Return all events reported in the current function group. The event symbols listed with the bit assignment of the `STATus:OPERation...` registers; for an example see *Table 5-5* on page 5.22.

A program example for symbolic status register evaluation is included in chapter 7 of this manual.

Serial Poll

In a serial poll, just as upon the command "`*STB`", the status byte of an instrument is queried. However, the query is made via interface messages and is thus clearly faster. The serial-poll method has already been defined in IEEE 488.1 and used to be the only standard possibility for different instruments to poll the status byte. The method also works for instruments which do not adhere to SCPI or IEEE 488.2.

The quick-BASIC command for executing a serial poll is "`IBRSP()`". The serial poll is mainly used to obtain a fast overview of the state of several instruments connected to the GPIB bus.

Parallel Poll

In a parallel poll, up to eight instruments are simultaneously requested by the controller by means of a single command to transmit 1 bit of information each on the data lines, i.e., to set the data line allocated to each instrument to a logic "0" or "1". By analogy to the SRE register which determines under which conditions an SRQ is generated, there is a parallel poll enable register (PPE) which is ANDed with the STB bit by bit, considering bit 6 – AND as well. The results are ORed, the result is then sent (possibly inverted) as a response to the parallel poll of the controller. The result can also be queried without parallel poll by means of the command "`*IST`".

The instrument first has to be set for the parallel poll using the quick-BASIC command "`IBPPC()`". This command allocates a data line to the instrument and determines whether the response is to be inverted. The parallel poll itself is executed using "`IBRPP()`".

The parallel-poll method is mainly used in order to quickly find out after an SRQ which instrument has sent the service request if there are many instruments connected to the GPIB bus. To this effect, SRE and PPE must be set to the same value.

Query by Means of Commands

Each part of any status register can be read by means of queries. The individual commands are listed in Chapter 6. What is returned is always a number which represents the bit pattern of the register queried. This number is evaluated by the controller program.

Queries are usually used after an SRQ in order to obtain more detailed information on the cause of the SRQ.

Error Queue Query

Each error state in the instrument leads to an entry in the error queue. The entries of the error queue are detailed plain-text error messages which can be looked at in the ERROR menu via manual control or queried via the GPIB bus using command "SYSTem:ERRor?". Each call of "SYSTem:ERRor?" provides one entry from the error queue. If no error messages are stored there any more, the instrument responds with 0, "No error".

The error queue should be queried after every SRQ in the controller program as the entries describe the cause of an error more precisely than the status registers. Especially in the test phase of a controller program the error queue should be queried regularly since faulty commands from the controller to the instrument are recorded there as well.

Reset Values of the Status Reporting Systems

Table 5-6 comprises the different commands and events causing the status reporting system to be reset. None of the commands, except for *RST and SYSTem:PRESet influences the functional instrument settings. In particular, DCL does not change the instrument settings.

Table 5-6 Resetting instrument functions

Event	**Switching on supply voltage**		**DCL,SDC (Device Clear, Selected Device Clear)**	***RST or SYSTem:PRESet**	**STATus:PRESet**	***CLS**
	Power-On-Status-Clear					
Effect	**0**	**1**				
Clear STB,ESR	—	yes	—	—	—	yes
Clear SRE,ESE	—	yes	—	—	—	—
Clear PPE	—	yes	—	—	—	—
Clear EVENt parts of the registers	—	yes	—	—	—	yes
Clear ENABle parts of all OPERation-and QUEStionable registers, Fill ENABle parts of all other registers with "1".	—	yes	—	—	yes	—
Fill PTRansition parts with „1" Clear NTRansition parts	—	yes	—	—	yes	—
Clear error queue	yes	yes	—	—	—	yes
Clear output buffer	yes	yes	yes	1)	1)	1)
Clear command processing and input buffer	yes	yes	yes	—	—	—

1) Every command being the first in a command line, i.e. immediately following a <PROGRAM MESSAGE TERMINATOR> clears the output buffer.

Measurement Control

The CMU offers a variety of measurements which are arranged in function groups and measurement groups. All measurements are controlled according to the same basic concepts. The benefit of this structure lies in the close analogy of all function groups. Commands belonging to different measurements have the same structure and syntax.

The following sections are devoted to the principles of measurement control:

- A measurement group can be split up into different subgroups by means of *applications* (optional, i.e. not available for every measurement group).
- Four different measurement states are defined; they can be accessed with a set of measurement control commands.
- The end of the measurement (or of a particular measurement stage) can be indicated by means of *the event reporting system.*
- Statistical settings comprising the repetition mode, statistic count (optional), stop condition (optional), and display mode (optional) control how the measurement is performed. The possible measurement states depend on the repetition mode.
- The current status and the results of the measurement can be queried in a systematic way.

Some measurements do not require the full scheme. E.g., the function group *RF Non Signalling* described in this manual uses none of the features characterized as optional in the above enumeration. Examples for these features can be found in the operating manuals for digital network tests, e.g., *GSM900/1800/1900-MS*.

Applications

Applications are different measurements belonging to the same measurement group. Each application is assigned its own set of configuration parameters. With few exceptions (e.g. some tolerance values), all parameters assigned to the applications can be different from each other. Thus, applications effectively split up a measurement group into various independent subgroups which can be configured individually and serviced in parallel.

The benefit of this feature is that the results of an application will not become invalid when another application in the same measurement group is started.

Applications are generally identified by the third-level keyword in a command while the measurement group is identified by the second-level keyword. Examples can be found in the operating manuals for the network tests.

Measurement Control Commands and States

Measurement control commands are used to switch over between the following four measurement states:

OFF	measurement is switched off, no results available (after `STOP`)
RUN	measurement is running
STOP	measurement has been stopped, valid results are preserved
STEP	measurement has been interrupted after a statistics cycle (in repetition mode *Continuous* or *Counting* with *Stepping* mode set in addition). The next cycle must be launched with a `CONTinue` command.

The *STOP* state corresponds to the *HLT* state indicated next to the softkeys controlling a measurement in manual operation. A *STEP* state is not defined in manual control.

The three measurement states *OFF, STOP,* and *STEP* can be mapped onto the standard SCPI state *IDLE*, the *RUN* state can be mapped onto the SCPI state *INITiated*. This and the relation between control commands and measurement states is shown in the following diagram:

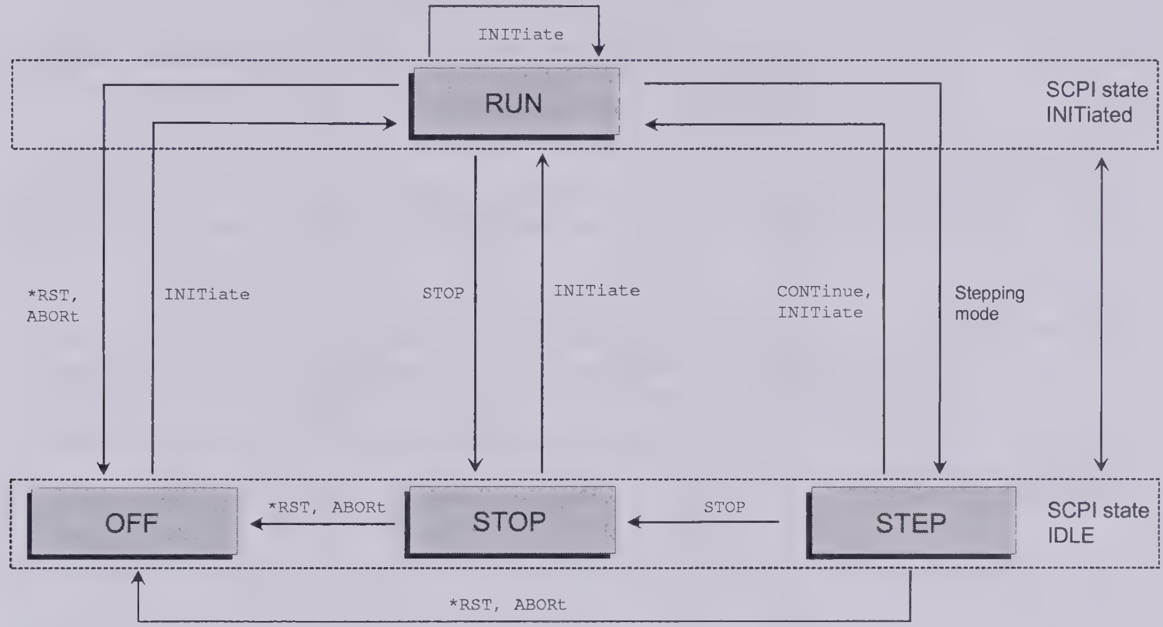


Fig. 5-7 Measurement states and control commands

The measurement control commands are supplemented by the measurement object, i.e.:

`INITiate:<meas_obj>` Starts a measurement in the repetition mode set via the `CONFigure:<meas_obj>:CONTrol:REPetition` command (single shot, continuous or counting mode, see section *Measurement Statistics* on page 5.34). The command resets the counters for the evaluation period and statistics (the latter is not used in RF measurements) to zero, furthermore, all measurement values are set invalid *(INV).*

As illustrated in *Fig. 5-7*, `INITiate` can be called in any measurement state. If the measurement is already running *(RUN),* `INITiate` aborts `(ABORt)` and restarts a running measurement.

The measurement reserves all necessary hardware resources and switches into the *RUN* state. If the measurement can not be started due to a resources conflict it remains in the *OFF* state, and the measurement status returned by the `FETCh:<meas_obj>:STATus?` is *ERR*. At the same time the SCPI error –213, *Init ignored*, is generated.

Possible resources conflicts

The RF connector is already allocated by another measurement or signal generator. The other measurement must be switched off first.

Due to the method used for the analysis, two measurements can not be evaluated at the same time.

Overlapping execution

`INITiate` is implemented as an overlapped command. In contrast to SCPI specifications, the `*OPC` command (see Chapter 6, *Common Com-*

mands) can not be applied together with the `INITiate` command. The *operation complete* bit (bit no. 0 in the event status register, ESR) is set immediately after the command sequence `INIT; *OPC`, i.e. as soon as the measurement is started and not after the end of the first evaluation period.

The command `CONFigure:<meas_obj>:EREPorting <Event>, <Mode>` represents a more flexible tool for generating a service request or setting the *operation complete* bit after the end of a measurement (see section *Event Reporting* on page 5.31).

`READ` command

Instead of `INITiate`, the `READ` command can be used to initiate a (single shot) measurement, see section *Retrieving Measurement Results* on page 5.35.

`ABORt:<meas_obj>`

Aborts the current measurement immediately and switches over to the *OFF* state. All measurement values are set invalid *(INV);* the hardware resources are released for other measurements.

As illustrated in *Fig. 5-7*, `ABORt` can be called in any measurement state.

Sequential execution

`ABORt` is implemented as a sequential command. This means that `ABORt` ist not complete until the measurement has released all resouces and has changed to the *OFF* state.

`STOP:<meas_obj>`

Stops (halts) the measurement as quickly as possible; i.e. after the end of the current evaluation period (or statistics cycle, if cycles comprising several evaluation periods are defined). The measurement changes to the *STOP* state such that all corresponding measurement values are kept unchanged. The hardware resources are retained.

As illustrated in *Fig. 5-7*, `STOP` can be called in the measurement states *RUN* and *STEP*. If called in the *OFF* state the command causes an SCPI error –221, *Settings conflict*.

Sequential execution

`STOP` is implemented as a sequential command. Execution of `STOP` is considered as complete as soon as the measurement state *STOP* is reached.

The `STOP` command causes no events which are set by the event reporting system (see section *Event Reporting* on page 5.31). This means that a service request must be explicitly requested by an `*OPC` command.

`CONTinue:<meas_obj>`

Resumes the measurement for the next measurement evaluation period and changes to the *RUN* state.

As illustrated in *Fig. 5-7*, `CONTinue` can be called in the measurement states *STOP* and *STEP*. If the previous measurement has been terminated (the measurement status returned by the `FETCh:<meas_obj>:STATus?` is *RDY)*, `CONTinue` restarts the measurement and resets the counters for the evaluation period and statistics (the latter is not used for RF measurements) to zero.

In the other measurement states the command causes an SCPI error –221, *Settings conflict*.

Overlapping execution	`CONTinue` is implemented as an overlapping command like `INITiate`. As a consequence, `*OPC` can not be used together with `CONTinue`.
Stepping mode	The stepping mode determines whether a measurement in the *counting* or *continuous* mode (see section *Measurement Statistics* on page 5.34) is interrupted after each evaluation period (or each statistics cycle, if cycles comprising several evaluation periods are defined) or not. The mode is set via the `<Stepmode>` parameter of the `CONFigure:<meas_obj>:CONTrol:REPetition CONTinuous | 1 ... 10000, <StopCondition>, <Stepmode>` command:

`<Stepmode> = STEP`	The measurement is interrupted (⇒ measurement state *STEP)* after each evaluation period, and the event reporting system (see p. 5.31) is invoked. The next measurement cycle must be started with the `CONTinue:<meas_object>` command.
`<Stepmode> = NONE`	The measurement runs according to its repetition mode. Event reporting is invoked only when the measurement stops (status = RDY).

Note: *STEP can be set in all repetition* modes (single shot, continuous, counting)*. For a single shot measurement which is always stopped after one evaluation period, the stepping mode has no effect.*

In function group *RF Non Signalling*, <meas_obj> can stand for any of the measurement objects `POWer and SPECtrum`.

Event Reporting

The event reporting system specifies in which way the CMU reports that a measurement or a measurement step has been correctly terminated, i.e., that the measurement status *STEP* or *RDY* has been reached. Event reporting is configured for each measurement group individually by means of the commands

`CONFigure:<meas_obj>:EREPorting SRQ | SOPC | SRSQ | OFF`

The parameters have the following meaning:

SRQ	Service request. A service request is generated (i.e. bit no. 6 (RQS/MSS) of the status byte (STB) is set) whenever the measurement status *STEP* or *RDY* is reached (see section *Service Request* on page 5.24).
SOPC	Single operation complete. The *operation complete* bit (bit no. 0 in the event status register) is set whenever the measurement status *STEP* or *RDY* is reached (see section *Status Reporting System* on page 5.16).
SRSQ	A service request is generated and the *operation complete* bit is set.
OFF	No special action is taken when the measurement status *STEP* or *RDY* is reached.

Note: *No action is taken if the* STOP *state is reached due to an explicit STOP command.*

Symbolic Measurement Ready Evaluation:

If event reporting is enabled (i.e. `CONFigure:<meas_obj>:EREPorting` is not set to `OFF`), each measurement that reaches the *STEP* or *RDY* status causes an entry in the *measurement queue*. The measurement queue can be queried by means of the `SYSTem:MQUeue[:COMPlete]<spec>?` commands described in Chapter 6.

Two different specifiers are provided:

`<spec> = [:LIST]`	Return the complete list of all ready measurements and reset all entries in the measurement queue to *NONE*.
`<spec> = :ITEM`	Return the next ready measurement in the list and reset the corresponding entry in the measurement queue to *NONE*.

Symbolic measurement ready evaluation is in order, e.g. to avoid inconsistencies when a `FETCh...?` command is used to retrieve measurement results (see section Retrieving Measurement Results on page 5.35).

Measurement Status

The status of the current measurement can be queried by means of the following command:

FETCh status `FETCh:<meas_obj>:STATus?`

Return the current status of the measurement. The `FETCh...` command can be used as well to poll the progress of a measurement. The response to the `FETCh...` query has the format `<Status>, <Counting_No>, <Statistic_No>`.

<Status> The first parameter in the response reports on the current status of the measurement. The measurement status returned is closely linked to the four measurement states described in section *Measurement Control Commands and States* on page 5.28 ff.:

OFF	measurement in the *OFF* state after *RST or `ABORt`
RUN	measurement in the *RUN* state after `INITiate`, `CONTinue`, or `READ`
STOP	measurement in the *STOP* state after `STOP` (stopped explicitly)
STEP	measurement in the *STEP* state due to `<Stepmode> = STEP`, valid measurement results
RDY	measurement in the *STOP* state because stopped according to the repetition mode and stop condition set.
ERR	measurement in the *OFF* state because it could not be started with `INITiate` or `READ` for lack of resources, e.g. because the RF connectors were already in use by another measurement.

<Counting_No> The second parameter in the response returns the current value of the statistics counter (the number of the current statistics cycle) if the measurement is performed in the *Counting* mode:

0 ... 10000	number of the current statistics cycle
NONE	no counter for statistics cycles used, i.e. a repetition mode other than *Counting* is set.

<Statistic_No> The third parameter in the response returns the number of the current *evaluation period* (e.g. a burst length in the case of *GSM Power vs Time* or *Modulation* measurements) within a statistics cycle. For *RF Non Signalling* Measurements this counter is not used (response *NONE*).

Generator Control

The commands used for control of the CMU's RF and AF signal generators are analogous to the measurement control commands explained on page 5.28. The generators are in one of the following two generator states:

OFF	generator switched off, resources released
RUN	generator running

The *RUN* state corresponds to the status indication *ON* in the *RF generator* softkey (see section *Analyzer/Generator Menu* in Chapter 4).

The relation between generator commands and generator states is shown in the following diagram:

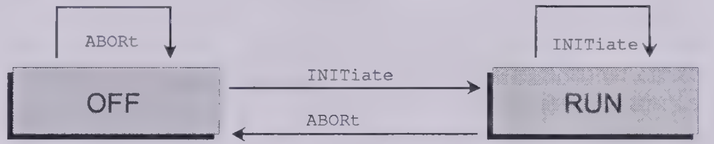


Fig. 5-8 Generator states and control commands

Generator control commands are recognized by the second-level keyword `RFGenerator` or `AFGenerator`. The generator control commands behave as follows:

`INITiate: RFGenerator` **`INITiate: AFGenerator...`**	Starts the generator, reserves all necessary hardware resources and changes to the generator state *RUN.* As illustrated in *Fig. 5-8,* `INITiate` can be called in any generator state. If the generator is already running *(RUN),* `INITiate` has no effect. If the generator can not be started due to a resources conflict it remains in the *OFF* state, and the measurement status returned by the `FETCh:<meas_obj>:STATus?` is *ERR.* At the same time the SCPI error –213, *Init ignored*, is generated.
Possible resources conflicts	• The RF connector is already allocated by another generator. The other generator must be switched off first.
Sequential execution	`INITiate` is implemented as a sequential command. The `*OPC` command (see Chapter 6, *Common Commands)* can be applied together with the `INITiate` command.
`ABORt: RFGenerator` **`ABORt: AFGenerator...`**	Switches the generator off, releases the hardware resources for other generators, and changes to the generator state *RUN.* As illustrated in *Fig. 5-8,* `ABORt` can be called in any generator state. If the generator is switched off *(OFF),* `ABORt` has no effect.
Sequential execution	`ABORt` is implemented as a sequential command. The command is not terminated before the generator is completely switched off.

Note: *In some measurements (e.g. in function group* Audio*), several RF or AF generators can be used, each of them corresponding to a separate application. In this case, one generator must be switched off* `(ABORt:...)` *before the application is changed and another generator is started. Otherwise, the measurement will be stopped and the CMU will display an error message.*

Generator Status

The generator status can be queried by means of the `FETCh...?` command:

FETCh command `FETCh:<meas_obj>:STATus?`

Return the current generator status. The `FETCh...` command can be used to poll the generator status. The `FETCh...` query returns one of the following generator states:

OFF	generator is in the *OFF* state (default status after `*RST` or due to `ABORt...` command).
RUN	generator running (*RUN* state after `INITiate...` command).
ERR	generator is in the *OFF* state because it could not be started with an `INITiate...` command for lack of resources (e.g. the RF connector is already in use by another generator).

Measurement Statistics

The *repetition mode* defines how many evaluation periods are measured if the measurement is not stopped explicitly (measurement control commands [illegible], `ABORt...`) in the meantime. In case of remote control the three repetition modes *Single Shot*, *Continuous* and *Counting* are available (*Counting* is not available in manual control, see Chapter 3).

Table 5-7 Repetition mode in remote control

Repetition mode	**Description**	**Command**
Single Shot	The measurement is stopped after one evaluation period, i.e., after evaluation of the trace over the whole time/frequency range	`CONFigure:<meas_obj>:CONTrol:REPetition` **`SINGleshot`**`, <StopCondition>, <Stepmode>` (in RF: `<meas_obj> = POWer | SPECtrum)`
Continuous	The measurement is continued until explicitly stopped. Results are valid after one evaluation period and updated after the next evaluation period has been terminated.	`CONFigure:<meas_obj>:CONTrol:REPetition` **`CONTinuous`**`, <StopCondition>, <Stepmode>` (in RF: `<meas_obj> = POWer | SPECtrum)`
Counting	Repeated single shot measurement with a definite number of evaluation periods. The stepping mode (<Stepmode> = STEP | NONE) determines whether the measurement is stopped after each evaluation period or not, see section *Measurement Control Commands and States* on page 5.28.	`CONFigure:<meas_obj>:CONTrol:REPetition` **`1 ... 10000`**`, <StopCondition>, <Stepmode>` (in RF: `<meas_obj> = POWer | SPECtrum)` (A counting measurement with 1 evaluation period is equivalent to a single shot measurement.)

The statistical evaluation is more refined for the digital network tests, see the relevant operating manuals. In particular, the counting mode is extended by introduction of statistics cycles consisting of an integer number of evaluation periods.

Retrieving Measurement Results

General command structure

The results of a measurement can be retrieved by means of the `FETCh`, `SAMPle` or `READ` query. All three commands have the same structure:

```
FETCh<type>:<meas_obj>[:RESult]<spec>?
SAMPle<type>:<meas_obj>[:RESult]<spec>?
READ<type>:<meas_obj>[:RESult]<spec>?
```

The literals written in angle brackets have the following meaning:

`<type>`	Measurement trace `(:ARRay)`, scalar values `([:SCALar])` can be retrieved in the network tests; see the relevant operating manuals. To limit the number of commands and simplify the program syntax, all scalar results determined in a measurement are generally read out with a single command. They are returned as a list of values separated by commas. The length of the arrays depends on the measurement group and possibly on the configuration settings; see also *Subarrays* paragraph below.
`<meas_obj>`	Measurement group (measurement object): `POWer | SPECtrum` are used in *RF Non Signalling* mode.
`<spec>`	`[:CURRent]` current evaluation period, other statistical traces can be retrieved in the network tests.

Subarrays

Arrays generally consist of a large number of values representing the measurement trace over the whole time or frequency range. With the `SUBarrays` commands, the CMU provides a flexible tool for handling large amounts of data. These commands restrict a measurement to up to 32 subranges where either all measurement results or a single statistical value can be read out.

Subarray configuration

The subarrays are configured with the following commands:

```
CONFigure:SUBarrays:<meas_obj> <Mode>, <Start>, <Samples>
                                              {,<Start>, <Samples>}
```

`<meas_obj>`	Measurement group (measurement object). For examples refer to the manuals for the network tests.
`<Mode>`	Statistics mode for **all** subranges. The following parameters can be set:

`ALL`	Return all measurement values (the number of values in every subrange is given by the `<Samples>` parameter).
`ARIThmetical`	Return the arithmetical mean value of the results in every subrange.
`MINimum`	Return the minimum of the results in every subrange.
`MAXimum`	Return the maximum of the results in every subrange.
`IVAL`	Return a single measurement value corresponding to the abscissa value <Start>. If <Start> is located between two test points with valid results then the result is calculated from the results at these two adjacent test points by linear interpolation. Ignore the <Samples> parameter.

`<Start>`	Start of current range (time or frequency or channel number).
`<Samples>`	Number of samples in current range.

The subranges may overlap but must be within the total range of the `<meas_obj>`. Test points outside this range are not measured (result *NAN)* and do not enter into the ARIThmetical, MINimum and MAXimum values.

By default, only one range corresponding to the total measurement range is used and all measurement values are returned.

Subarray results

Subarray results are retrieved by means of `FETCh`, `SAMPle` or `READ` queries, with `:SUBarrays` inserted as a second-level keyword:

```
FETCh:SUBarrays<type>:<meas_obj>[:RESult]<spec>?
SAMPle:SUBarrays<type>:<meas_obj>[:RESult]<spec>?
READ:SUBarrays<type>:<meas_obj>[:RESult]<spec>?
```

In the default subarray configuration, these commands are identical with the `FETCh`, `SAMPle` or `READ` queries described above (i.e. all measurement results are read out).

FETCh command

```
FETCh<type>:<meas_obj>[:RESult]<spec>?
```

Retrieves the latest valid measurement results.

If the `FETCh` query is used immediately after an `INITialize...` command, the first evaluation period is terminated before the query is executed so that a valid result can be acquired. If called up repeatedly after termination of the first evaluation period, the `FETCh` query may return the same results several times until they have been updated after the next period.

A `FETCh` returns the results without interaction with the measurement (unsynchronized query). In some cases this may cause inconsistent results to be read so that the `SAMPle` command should be used while the measurement is in the *RUN* state.

Measurement states

According to the definition given above the effect of the `FETCh` query depends on the measurement status and the history of the measurement:

Status	Valid Results?	Effect of `FETCh...`?
≠ OFF	Yes	Returns the current results
OFF	No	Generates an SCPI error –230, *Data corrupt or stale*. This is why `FETCh` should not be used while the measurement is in the *OFF* state.
RUN	No	Waits until valid results are available and returns these results.
STOP	No	Generates an SCPI error –230, *Data corrupt or stale*. This scenario occurs, e.g. if the measurement is stopped explicitly before the first evaluation period has been terminated.

SAMPle command

```
SAMPle<type>:<meas_obj>[:RESult]<spec>?
```

Retrieves the results of the current evaluation period. In single shot measurements, `SAMPle` is equivalent to `READ`.

In a *continuous* measurement, or in *counting* mode (see *repetition mode* in *Table 5-7*), `SAMPle` is executed only after termination of the current evaluation period. This implies that a single measurement result can be returned only once by a `SAMPle` query; if called up repeatedly, `SAMPle` will return the result of subsequent evaluation periods.

Due to this behavior, the `SAMPle` query is suitable for monitoring the progress of *continuous* measurements in time. Multiple identical results, which might be returned by repeated `FETCh` commands, are avoided.

A `SAMPle` query returns the results after interacting with the measurement (synchronized query). This means that only valid results are returned, inconsistencies are avoided.

Measurement states According to the definition given above the effect of the `SAMPle` query depends on the measurement status and the history of the measurement:

Status	**Valid Results?**	**Effect of `SAMPle...?`**
STOP | RDY | STEP	Yes	Returns the current results. In this case, the `SAMPle` command is equivalent to the `FETCh` command.
OFF	No	Generates an SCPI error –230, *Data corrupt or stale*. This is why `SAMPle` should not be used while the measurement is in the *OFF* state.
RUN	Yes | No	Waits until the end of the current evaluation period, returns the results, and resumes the measurement (unless the current evaluation period is the last to be measured).
STOP	No	Generates an SCPI error –230, *Data corrupt or stale*. This scenario occurs, e.g. if the measurement is stopped explicitly before the first evaluation period has been terminated.

READ command

```
READ<type>:<meas_obj>[:RESult]<spec>?
```

Starts a new measurement, terminates the measurement and returns the results after one single shot. The `READ...?` query is equivalent to:

```
ABORt...;
INITiate...;
FETCh...?
```

The `READ` command preserves all configurations (such as event reporting, stop condition, statistics count...). `READ` initiates a measurement which is terminated after one single shot (⇒ measurement state *STOP*, status *RDY*; if an error occurred, the status is *ERR*). However, it does not affect the repetition mode setting itself.

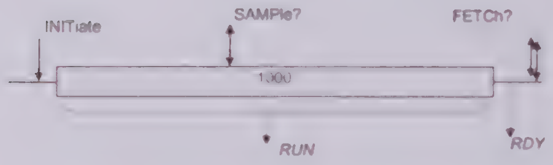
In case of no error (status *RDY*), the measurement can be continued by means of the `CONTinue` command. It will be performed with the repetition mode set before `READ` was executed.

Diagrammatic Overview of Measurement Control

As pointed out in the previous sections the commands used to configure and control the measurements, to query the status of the measurement, and to retrieve the measurement results are closely linked to the settings for the repetition mode and stop condition. The various scenarios are most easily explained by means of a graphical representation of the measurements.

Single Shot Measurements

Stop condition: NONE

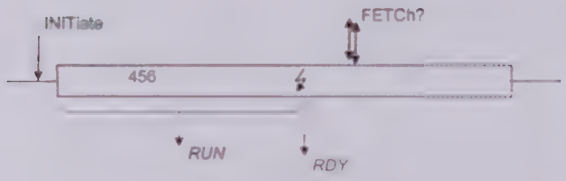


A single shot measurement comprising 1000 evaluation periods with stop condition none is performed. The measurement is started with the `INITiate` command. The results can be queried using the `SAMPle...?` (status *RUN* or *RDY)* or `FETCh...?` (status *RDY)* commands. The measurement is configured via:

```
CONFigure:<meas_obj>:CONTrol <type>,1000
CONFigure:<meas_obj>:CONTrol:REPetition
        SINGleshot,NONE,<Stepmode>
```

The <Stepmode> parameter has no effect.

Stop condition: SONerror



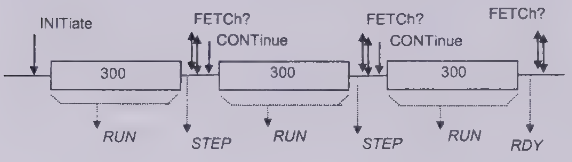
A single shot measurement comprising 1000 evaluation periods with stop condition SONerror is performed. The measurement is started with the `INITiate` command and stopped before the end of the statistics cycle. The results can be queried using the `SAMPle...?` (status *RUN* or *STOP)* or `FETCh` (status *STOP)* commands. The number of bursts measured can be queried using the `FETCh:<meas_obj>:STATus?` command. The measurement is configured via:

```
CONFigure:<meas_obj>:CONTrol <type>,1000
CONFigure:<meas_obj>:CONTrol:REPetition
                      SINGleshot,SONerror
                      <Stepmode>
```

The <Stepmode> parameter has no effect.

Counting Measurements

Stop condition: NONE

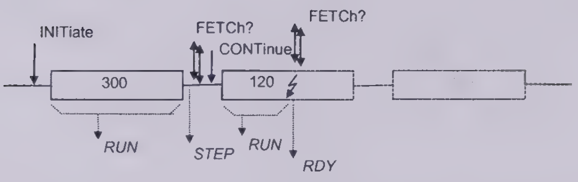

INITiate
FETCh?
CONTinue
FETCh?
CONTinue
FETCh?
300
300
300
RUN
STEP
RUN
STEP
RUN
RDY

A counting measurement comprising 3 counts of measurements, each about a statistics cycle of 300 evaluation periods, is performed. The measurement is started with the `INITiate` command. The results can be queried using the `SAMPle...?` (status *RUN, STEP* or *RDY)* or `FETCh...?` (status *STEP* or *RDY)* commands. The measurement is configured via:

```
CONFigure:<meas_obj>:CONTrol <type>,300
CONFigure:<meas_obj>:CONTrol:REPetition
                             3,NONE,<Stepmode>
```

The STEP status occurs only if the stepping mode is set (`<Stepmode> = STEP`). In this case, the next cycle must be restarted via the `CONTinue` command.

Stop condition: SONerror


INITiate
FETCh?
CONTinue
FETCh?
300
120
RUN
STEP
RUN
RDY

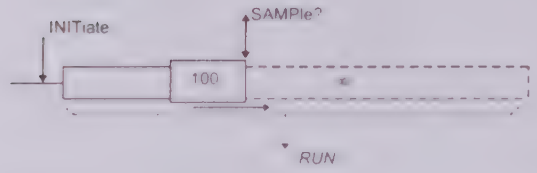
A counting measurement comprising counts of measurements, each about a statistics cycle of 300 evaluation periods, is performed. The measurement is started with the `INITiate` command. The results can be queried using the `SAMPle...?` (status *RUN, STEP* or *RDY)* or `FETCh...?` (status *STEP* or *RDY)* commands. The measurement is configured via:

```
CONFigure:<meas_obj>:CONTrol <type>,300
CONFigure:<meas_obj>:CONTrol:REPetition
                             3,SONerror,<Stepmode>
```

The STEP status occurs only if the stepping mode is set (`<Stepmode> = STEP`). In this case, the next cycle must be restarted via the `CONTinue` command.

Continuous Measurements

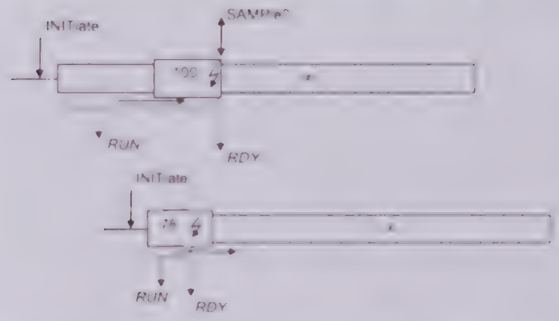
Statistics cycles, stop condition: NONE



A continuous measurement with statistics cycles consisting of 100 bursts each is performed. Average results are calculated according to the rules given in chapter 3. The measurement is started with the `INITiate` command. Results can be queried using the `SAMPle...?` command (status *RUN)*. During the measurement `FETCh...?` may return inconsistent results. The measurement is configured via:

```
CONFigure:<meas_obj>:CONTrol <type> 100
CONFigure:<meas_obj>:CONTrol:REPetition
                              CONTinuous,NONE,NONE
```

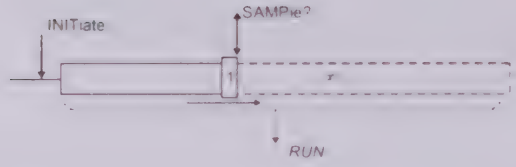
Statistics cycles, stop condition: SONerror



A continuous measurement with statistics cycles consisting of 100 evaluation periods each is performed. The measurement is started with the `INITiate` command. Results can be queried the `SAMPle...?` command (status *RUN, STOP)*. During the measurement `FETCh...?` may return inconsistent results. If the stop condition is met during the first statistics cycle no valid result is available. The measurement is configured via:

```
CONFigure:<meas_obj>:CONTrol <type> 100
CONFigure:<meas_obj>:CONTrol:REPetition
                              CONTinuous,SONerror,NONE
```

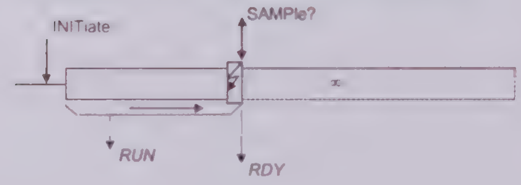
Statistics off, stop condition: NONE



A continuous measurement is performed. No statistics cycles are defined. The measurement is started with the `INITiate` command. Results can be queried using the `SAMPle...?` command (status *RUN)*. During the measurement `FETCh...?` may return inconsistent results. The measurement is configured via:

```
CONFigure:<meas_obj>:CONTrol <type> OFF
CONFigure:<meas_obj>:CONTrol:REPetition
                              CONTinuous,NONE,NONE
```

Statistics off, stop condition: SONerror



A continuous measurement is performed. No statistics cycles are defined. The measurement is started with the `INITiate` command. Results can be queried the `SAMPle...?` command (status *RUN, STOP)*. During the measurement `FETCh...?` may return inconsistent results. The measurement is configured via:

```
CONFigure:<meas_obj>:CONTrol <type> OFF
CONFigure:<meas_obj>:CONTrol:REPetition
                              CONTinuous,SONerror,NONE
```

Note: *The stepping mode can be set for continuous measurements as well (Parameter `<Stepmode>=STEP`, see section Counting Measurements on page 5.39). In this case, the system takes up the STEP status after each statistics cycle. It can be relaunched via the `CONTinue` command.*

Special Terms and Notation

Below we list some particular features in the syntax of the remote control commands. The general description of the SCPI command syntax can be found in section *Structure and Syntax of Device Messages* on page 5.7.

Descript**ion of commands**

The commands are arranged in tables; all of them are arranged in the same way. From top to bottom, the table rows contain the following entries:

1. Complete command syntax including the parameter list and a short description of the command,
2. List and description of the parameters with their default values, the units, and unit rings.
3. Detailed description of the command, signalling state required for command execution, required firmware version.

Extensive lists of default values are annexed to the command description.

Order of commands

The commands are arranged according to their function. The general purpose of a command is described by the keyword in the second level. Lower-level keywords define the command in more detail. This means that commands with the same second-level, third-level etc. keywords are generally grouped together in the same sections.

Example:

```
CONFigure:POWer:MARKer:REFerence:POSition
                           <Position>
```

Commands with the keyword *POWer* in the second level belong to the power measurement. The keywords in the third, fourth and fifth level indicate that the command defines the position of the reference marker used in the power measurement.

Measurement object

The term *measurement object* denotes a group of remote control commands relating to the same group of measured quantities. E.g., all commands concerning the measurement of the signal power vs time form a common measurement object.

Combined measurements

To limit the number of remote control command and their parameters, scalar quantities of the same measurement object are always measured together and returned in lists.

Parameters

Many commands are supplemented by a parameter or a list of parameters. Parameters either provide alternative options (setting a or setting b or setting c ..., see special character "|"), or they form a list separated by commas (setting x,y).

<Par_Name>

In the command tables and lists, parameters are generally described by a name (literal) written in angle brackets (<>). This literal merely serves as a parameters description; in an application program it must be replaced by one of the possible settings reported in the detailed parameter description.

Example: `CONFigure:POWer:CONTrol <Mode>,<Statistics>`

with `<Mode>` = `SCALar | ARRay`
`<Statistics>` = `1 to 10000 | NONE`

possible command syntax: `CONF:POW:CONT SCAL,OFF`

NAN

NAN (not a number) is generally used to represent missing data, e.g. if a portion of a trace has not been acquired yet. It is also returned after invalid mathematical operations such as division by zero. As defined in the SCPI standard, NAN is represented as 9.91 E 37.

INV

INV (invalid) is returned if a limit check is performed without defining the appropriate tolerance values.

Upper / lower case

Upper/lower case characters characterize the long and short form of the keywords in a command. The short form consists of all upper-case characters, the long form of all upper case plus all lower case characters. On the CMU, either the short form or the long form are allowed; mixed forms will generally not be recognized. Either the short form or the long form are permissible. The instrument itself does not distinguish upper case and lower case characters.

Special characters

| A vertical stroke in the parameter list characterizes alternative parameter settings. Only one of the parameters separated by | must be selected.

Example: The following command has two alternative settings:

```
TRIGger:SEQuence:DEFault ON | OFF
```

[ ] *Key words* in square brackets can be omitted when composing the command header (see Chapter 5 of the CMU manual, section "Structure of a Command"). The complete command must be recognized by the instrument for reasons of compatibility with the SCPI standard.
Parameters in square brackets are optional as well. They may be entered in the command or omitted.

{ } Braces or curly brackets enclose one or more parameters that may be included zero or more times.

<nr> This symbol stands for a numeric suffix, e.g. an enumeration index for input and output connectors.

Lists of commands

Command: The *Command* column of the table contains all remote control commands arranged according to their function (configurations or measurement objects). Within a section, the commands are listed in alphabetical order.

Parameters: The *Parameter* column lists the parameters of the commands.

Remarks: The *Remarks* column gives additional information about the commands which

- Have no query form *(no query)*
- Have only a query form *(query only)*
- Can be used both as setting commands and as queries (*with query*, this applies to all commands belonging to none of the two preceding categories)

Alphabetical Lists Chapter 6 concludes with alphabetical command lists for both test modes.

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6 Remote Control – Commands

In the following, all remote-control commands for the *Base* system and the function groups *RF* and *Audio* will be presented in tabular form with their parameters and the ranges of numerical values. The chapter is organized as follows:

- Common commands, commands for the base system and the function groups *RF* and *Audio* are presented separately.
- Within the measurement modes, first the general configuration and then the individual measurement groups are described.

An introduction to remote control according to the SCPI standard, the status registers of the CMU, and the operating concept and measurement control is given in chapter 5.

Common Commands

The common commands are taken from the IEEE 488.2 (IEC 625-2) standard. These commands have the same effect on different devices. The headers of these commands consist of "*" followed by three letters. Many common commands are related to the status reporting system which is described in detail in chapter 5.

Table 6-1 Common Commands

Command	**Parameters**	**Remark**
***CLS**		no query
***ESE**	0 to 255	
***ESR?**		query only
***GTL**		not IEEE 488.2 confirmed; see p. 6.15 and Chapter 8, *Addressed Commands*
***IDN?**		query only
***IST?**		query only
***LLO**	TRUE | FALSe	not IEEE 488.2 confirmed; see p. 6.17 and Chapter 8, *Universal Commands*
***OPC**		
***OPT?**		query only
***PRE**	0 to 255	
***PSC**	0 | 1	
***RST**		no query
***SEC**	0 to 30	not IEEE 488.2 confirmed; see p. 6.11
***SRE**	0 to 255	
***STB?**		query only
***TST?**		query only
***WAI**		

***CLS**

CLEAR STATUS sets the status byte (STB), the standard event register (ESR) and the EVENt-part of the QUEStionable and the OPERation register to zero. The command does not alter the mask and transition parts of the registers. It clears the output buffer.

***ESE** 0 to 255

EVENT STATUS ENABLE sets the event status enable register to the value indicated. Query *ESE? returns the contents of the event status enable register in decimal form.

***ESR?**

STANDARD EVENT STATUS QUERY returns the contents of the event status register in decimal form (0 to 255) and subsequently sets the register to zero.

***IDN?**

IDENTIFICATION QUERY queries the instrument identification.

***IST?**

INDIVIDUAL STATUS QUERY returns the contents of the IST flag in decimal form (0 | 1). The IST-flag is the status bit which is sent during a parallel poll (see chapter 5).

***OPC**

OPERATION COMPLETE sets bit 0 in the event status register when all preceding commands have been executed. This bit can be used to initiate a service request (cf. chapter 5).

***OPC?**

OPERATION COMPLETE QUERY writes message "1" into the output buffer as soon as all preceding commands have been executed (cf. chapter 5).

***OPT?**

OPTION IDENTIFICATION QUERY queries the options included in the instrument and returns a list of the options installed. The response consists of Arbitrary ASCII Response Data according to IEEE 488.2. The options are returned at fixed positions in a comma-separated string. A zero is returned for options that are not installed.

Example:

```
0,0,0,0,B11,0,B21Var02,0,0,0,B41,B52Var02,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,PCMCIA,0,
0,0,0,0,0,0,0,K20,K21,K22,K23,K24,K27,K28,K29,0,0,0,0,0,0,0,K42,K43,0,0,0,0,0,0,0,0,0,0,K83,K84,
K85,K86,0,FMR5,AMD K6-2,64 MB,0,0,0,rxtx1,0,0,0,0,0
```

An alternative list of options can be queried via the command SYSTem:OPTions? See also description of *Setup – Options* menu in Chapter 4.

The CMU hardware options are listed at the beginning of the output string:

Response	Description	Response	Description
B1/B2	OCXO	B54Var02/Var14	Sig. Mod. for GSM, TDMA, AMPS
B5	GSM Linkhandler (CRTU)	B56Var14	Power PC for USU
B6	MAC/Speech Board (CRTU)	B56Var02/Var14	Power PC
B7	I/Q-IF Interface (CRTU)	B66	WCDMA L1 Copro
B9	Two auxiliary RF generators	B68	WCDMA L1 Copro, fully fitted
B11/B12	OCXO	B71	ABIS (CMU300)
B17	I/Q-IF Interface	B73	A/B Board
B21	Universal Signalling Unit	B76	WCDMA L1 Copro (CMU300)
B21Var14	USU for WCDMA, GPRS	B81	cdmaOne LH

Response	Description	Response	Description
B21Var02	ULH for GMS, TDMA, AMPS	B82	Access Board for B81/83
B21Var02/Var14	Universal Signalling Unit	B83	CDMA2000 LH
B41	Audio option	B85	Speech codec for B83
B52	Speech coder for CMU-B21	B88	HDR option for B83
B52Var14	Speech coder for USU	B91	Second RF Channel
B52Var02	Speech coder for ULH	B95	Additional RF Generator
B52Var02/Var14	Speech coder	U61	Floppy disk
B53	Bluetooth	B62	–
B53Var14	Bluetooth for USU	U65	DDC400 for WCDMA
B53Var02	Bluetooth for ULH	U75	DDC400 for WCDMA Var04
B53Var02/Var14	Bluetooth	U99	RF1 with RF2 Level Range
B54Var14	Sig. Mod. f. GSM, TDMA, AMPS	0	not used

The CMU software options are listed after the software options:

Response	Description	Response	Description
K0	DemoPack	K43	EGPRS Signalling
K2	GSM Activation (CRTU)	K45	AMR GSM for CMU200
K5	CRTU-G Activation (CRTU)	K53	Bluetooth
K6	WCDMA Activation (CRTU)	K65	WCDMA UE TX Test (3GPP/FDD)
K20	GSM400-MS	K66	WCDMA DL Generator
K21	GSM900-MS	K67	WCDMA Signalling Band III
K22	GSM1800-MS	K68	WCDMA Signalling Band I
K23	GSM1900-MS	K69	WCDMA Signalling Band II
K24	GSM850-MS	K75	WCDMA Node B Test (CMU300)
K27	IS 136-800-MS	K76	WCDMA UL Generator (CMU300)
K28	IS 136-1900-MS	K81	CDMA1-MS 800
K29	AMPS-MS	K82	CDMA1-MS 1700/1900
K30	GSM400-BS	K83	CDMA2000 450
K31	GSM900-BS	K84	CDMA2000 800
K32	GSM1800-BS	K85	CDMA2000 1700/1900
K33	GSM1900-BS	K86	CDMA2000 2200
K34	GSM850-BS	K88	1xEV-DO
K39	MOC/MTC for GSM-BS		
K41	EDGE		
K42	GPRS Signalling		

The CMU hardware equipment is listed after the hardware options:

Response	Description	Response	Description
FMR5/6	Front Module Controller	0	not used
<CPU_Type>	–	0	not used
<Memory>	–	0	not used

The CMU firmware versions are listed after the hardware equipment:

Response	Description	Response	Description
uP1	–	0	not used
uP2	–	0	not used
0	not used	0	not used

***PRE 0 to 255**

PARALLEL POLL REGISTER ENABLE sets parallel poll enable register to the value indicated. Query *PRE? returns the contents of the parallel poll enable register in decimal form.

***PSC 0 | 1**

POWER ON STATUS CLEAR determines whether the contents of the ENABle registers is maintained or reset in switching on.

*PSC = 0	causes the contents of the status registers to be maintained. Thus a service request can be triggered in switching on in the case of a corresponding configuration of status registers ESE and SRE.
*PSC = 0	resets the registers.

Query *PSC? reads out the contents of the power-on-status-clear flag. The response can be 0 or 1.

***RST**

RESET sets the instrument to a defined default status. The command resets all function groups and test modes, restoring the default values defined for remote control operation. *RST is equivalent to [illegible]. The default settings are indicated in the description of commands.

***SRE 0 to 255**

SERVICE REQUEST ENABLE sets the service request enable register to the value indicated. Bit 6 (MSS mask bit) remains 0. This command determines under which conditions a service request is triggered. Query *SRE? reads the contents of the service request enable register in decimal form. Bit 6 is always 0.

***STB?**

READ STATUS BYTE QUERY reads the contents of the status byte in decimal form.

***TST?**

SELF TEST QUERY triggers selftests of the instrument and outputs an error code in decimal form (the output is zero in the current firmware version).

***WAI**

WAIT-to-CONTINUE only permits the servicing of the subsequent commands after all preceding commands have been executed and all signals have settled (see also chapter 5 and "*OPC").

CMU Base System

System Commands

The SYSTem subsystem contains the functions that are not related to instrument performance. The CMU supports the following SCPI-confirmed SYSTem commands:

SYSTem:ERRor?				Error Queue
Response	Parameter description	Def. value	Default unit	FW vers.
-32768 to +32768 and error string **Ex.: -230,"Data corrupt or stale"**	Error message	0, "No error"	–	V1.20
Command description				
This command queries the next entry from the error/event queue and deletes it. Positive error numbers are instrument-dependent; negative error numbers are reserved by the SCPI standard, see chapter 9. If the error queue is empty, the error number 0, "No error" is returned.				

SYSTem:VERSion?				SCPI Version
Response	Parameter description	Def. value	Default unit	FW vers.
YYYY.V **Ex.: 1990.0**	SCPI version of CMU	–	–	V1.20
Command description				
This command queries the SCPI version number for which the instrument complies. YYYY is the year of SCPI compliance, V is the version number within the year.				

SYSTem:NONVolatile:DISable	Disable Non Volatile RAM
Command description	FW vers.
This command has no query form. It prevents the CMU from saving measurement settings to the non volatile ram. This improves the system performance but implies that the current settings will not be saved for later sessions. Disabling the non volatile ram is recommended on instruments equipped with an FMR 6 Front Module controller. **Note:** *There is no way to cancel the effect of the* `SYSTem:NONVolatile:DISable` *command within the current session, even is the CMU is switched to manual control (Local). To re-enable the non volatile ram, the CMU must be rebooted.*	V3.0

Status Commands

The STATus subsystem controls the SCPI-defined status reporting structures. The purpose and definition of status registers is given in chapter 5, section "Status Reporting System". Unless otherwise stated, all the following commands are SCPI-confirmed.

STATus:OPERation[:EVENt]? Event Part

Response	Parameter description	Def. value[1]	Default unit	FW vers.
0 to 32767	Event part	–	–	V1.20

Command description

This command queries and deletes the contents of the EVENt part of the STATus:OPERation register.

STATus:OPERation:ENABle *<Number>* Enable part

<Number>	Parameter description	Def. value	Default unit	FW vers.
0 to 32767	Enable part	–	–	V1.20

Command description

This command enters a number to be interpreted as a bit pattern in the ENABle part of the STATus:OPERation register. If a bit is set the corresponding event is reported in the summary bit of the status byte.

STATus:OPERation:CMU:SUM<nr>[:EVENt]? Event part

Response	Parameter description	Def. value	Default unit	FW vers.
0 to 32767	Event part	–	–	V1.20

Command description

This command queries and deletes the contents of the EVENt part of the STATus:OPERation:CMU:SUM<nr> register (<nr> = 1,2).

STATus:OPERation:CMU:SUM<nr>:ENABle *<Number>* Enable part

<Number>	Parameter description	Def. value	Default unit	FW vers.
0 to 32767	Enable part	–	–	V1.20

Command description

This command enters a number to be interpreted as a bit pattern in the ENABle part of the STATus:OPERation:CMU:SUM<nr> register (<nr> = 1,2). If a bit is set the corresponding event is reported in the summary bit of the status byte.

STATus:OPERation:CMU:SUM<nr>:CMU<nr_event>[:EVENt]? Event part

Response	Parameter description	Def. value	Default unit	FW vers.
0 to 32767	Event part	–	–	V1.20

Command description

This command queries and deletes the contents of the EVENt part of the STATus:OPERation:CMU:SUM<nr>:CMU<nr_event> register (<nr> = 1 to 2; <nr_event> = 1 to 15).

---

[1] `*RST` does not supersede the entries in the status registers; for an overview of the reset values of the `STATus...` system refer to section *Reset Values of the Status Reporting Systems* in chapter 5.

STATus:OPERation:CMU:SUM<nr>:CMU<nr_event>:ENABle *<Number>* Enable part

<Number>	Parameter description	Def. value	Default unit	FW vers.
0 to 32767	Enable part	–	–	V1.20

Command description

This command enters a number to be interpreted as a bit pattern in the ENABle part of the STATus:OPERation:CMU:SUM<nr>:CMU<nr_event> register (<nr> = 1 to 2; <nr_event> = 1 to 15). If a bit is set the corresponding event is reported in the summary bit of the status byte.

STATus:OPERation:CMU:ALL? Query all operation registers

Response	Parameter description	Def. value	Default unit	FW vers.
0 to 32767, ... , 0 to 32767	Event part of all CMU operation registers	–	–	V1.20

Command description

This command queries the EVENt parts of all STATus:OPERation:CMU:SUM<nr>:CMU<nr_event> registers. The result is returned as a list of 30 integer values separated by commas.

STATus:OPERation:CMU:CLEar Clear all operation registers

Command description	FW vers.
This command clears the EVENt parts of all STATus:OPERation:CMU:SUM<nr>:CMU<nr_event> registers (<nr> = 1 to 2; <nr_event> = 1 to 15).	V1.20

STATus:QUEStionable[:EVENt]? Event part

Response	Parameter description	Def. value	Default unit	FW vers.
0 to 32767	Event part	–	–	V1.20

Command description

This command queries and deletes the contents of the EVENt part of the STATus:QUEStionable register.

STATus:QUEStionable:ENABle *<Number>* Enable part

<Number>	Parameter description	Def. value	Default unit	FW vers.
0 to 32767	Enable part	–	–	V1.20

Command description

This command enters a number to be interpreted as a bit pattern in the ENABle part of the STATus:QUEStionable register. If a bit is set the corresponding event is reported in the summary bit of the status byte.

STATus:PRESet	Reset status registers
Command description	FW vers.
This command sets the transition filters (PTRansition and NTRansition filters) and the ENABle registers of the STATus:OPERation and the STATus:QUEStionable registers to defined values: • PTRansition is set to 32767 (0x7FFF), i.e. all hardware events are detected and transferred to the EVENt register. • NTRansition is set to 0, i.e. a hardware event that disappears does not cause any change in the EVENt register. The ENABle registers are also set to 0 so that events are not reported in the status byte.	V1.20

Symbolic Status Event Register Evaluation

The following commands are used to retrieve the events reported and the corresponding function groups; see section *Symbolic Status Event Register Evaluation* in chapter 5.

STATus:OPERation:EVENt:SADDress? Check event reporting

Response	Parameter description	Def. Value[2]	Default Unit	FW vers.
1 to 30,	"Next" secondary address	31	–	V2.10
"Fgrp"	Corresponding function group name (or "", if no event was reported)	""	–	

Command description

This command is always a query. It checks the `STATus:OPERation: CMU:SUM<nr>:EVENt` sum registers (<nr> = 1 | 2), returns the next secondary address and function group string where an event was reported, and deletes the entry in the `EVENt` register. If applied repeatedly, the command checks the secondary addresses in ascending order (i.e. the events are not queried chronologically).

The command is global; it is available in all function groups. Possible responses are:

1,"RF_NSig"	An event was reported in function group *RF* (currently assigned to secondary address 1).
31,""	No (further) event reported.

STATus:OPERation:SYMBolic:ENABle <Event>{,<Event>} Symbolic status evaluation

Parameter list	Parameter description	Def. Value[3]	Default Unit	FW vers.
<Event>{,<Event>} |	List of symbols for events to be reported	NONE	–	V2.10
NONE	No event reported			

Command description

This command enables event reporting for one or several events in the current function group, i.e. it sets the corresponding bits in the `STATus:OPERation:CMU: SUM<nr>:CMU<nr_event>:ENABle` register (`<nr> = 1 | 2, <nr_event>` denotes the current function group) and in all sum registers up to the status byte. The events and the corresponding symbols for each function group are listed in chapter 5 of the relevant manuals (see section *Status Registers*). The symbols may be entered in arbitrary order.

STATus:OPERation:SYMBolic[:EVENt]? Symbolic status evaluation

Response	Parameter description	Def. Value[4]	Default Unit	FW vers.
NONE |	No event in the current function group	NONE	–	V2.10
<Event>{,<Event>}	List of reported events			

Command description

This command is always a query. It lists the events reported in the current function group and deletes these events in the `STATus:OPERation:CMU:SUM<nr> :CMU<nr_event>:EVENt` register as well as in all sum registers.

---

[2] The default values quoted in this command are achieved after a `*CLS` command. `*RST` does not supersede the entries in the status registers; see section *Reset Values of the Status Reporting Systems* in chapter 5.

[3] The default values quoted in this command are achieved after a `STATus:PRESet` command. `*RST` does not supersede the entries in the status registers; see section *Reset Values of the Status Reporting Systems* in chapter 5.

[4] The default values quoted in this command are achieved after a `*CLS` command. `*RST` does not supersede the entries in the status registers; see section *Reset Values of the Status Reporting Systems* in chapter 5.

Setup – Basic Device Settings

The SETup subsystem contains the commands for global configuration of the remote control parameters, the serial interfaces, the options, date and time, the keyboard and beeper. It corresponds to the *Setup* menu opened via the *SETUP* key on the front panel.

Subsystem Remote

The *REMote* subsystem contains the commands for configuration of the remote control parameters. It corresponds to the *Remote* tab in the *Setup* menu opened via the *SETUP* key on the front panel.

SYSTem:REMote:ADDRess:PRIMary *<Addr>* Primary Address

<Addr>	Parameter description	Def. value	Default unit	FW vers.
0 to 30	Primary address to the GPIB (IEEE) bus	20	–	V1.20

Command description

This command sets the primary address of the GPIB driver which is used to address the device (CMU). It is equivalent to `SYSTem:COMMunicate:GPIB[:SELF]:ADDRess` (see below).

SYSTem:REMote:ADDRess:SECondary *<Addr>,<FGrp>* Secondary Address

<Addr>,<FGrp>	Parameter description	Def. value	Default unit	FW vers.
1 to 29, **„FGrp_name“ |** **NONe**	Secondary address of the function group Name of the function group or NONE if the secondary address is not to be mapped	Configuration specific	–	V1.17

Command description

This command assigns the secondary addresses to the remote control modes (function groups) of the GPIB driver (compare next command). If a secondary address is successively assigned to different function groups, the previous assignments are overwritten. The function group names are quoted at the beginning of chapter 5 of each network test manual; some examples are:

FGrp_name	Function Group	FGrp_name	Function Group
BASE	CMU base system	Audio_NSig	Audio Generator and Analyzer
RF_NSig	RF Non Signalling	IS136800MS_NSig	TDMA800-MS Non Signalling
GSM900MS_NSig	GSM900-MS Non Signalling	IS136800MS_Sig	TDMA800-MS Signalling
GSM900MS_Sig	GSM900-MS Signalling	IS1361900MS_NSig	TDMA1900-MS Non Signalling
GSM1800MS_NSig	GSM1800-MS Non Signalling	IS1361900MS_NSig	TDMA1900-MS Signalling
GSM1800MS_Sig	GSM1800-MS Signalling	AMPSMS_NSig	AMPS-MS Non Signalling
GSM1900MS_NSig	GSM1900-MS Non Signalling	AMPSMS_Sig	AMPS-MS Signalling

The CMU base system (function group *BASE)* is always assigned to secondary address 0; the assignment cannot be changed by the `SYSTem:REMote:ADDRess:SECondary` command. A program example illustrating how to adapt the secondary addresses to the requirements of a specific driver can be found in chapter 7.

Example:	Setting:	SYST:REM:ADDR:SEC 2,"GSM900MS_NSig" SYST:REM:ADDR:SEC 1,NONE
	Query: --> Response:	SYST:REM:ADDR:SEC? 2 "GSM900MS_NSig"
	Query: --> Response:	SYST:REM:ADDR:SEC? 1 NONE
	Query: --> Response:	SYST:REM:ADDR:SEC? NONE,"GSM900MS_NSig", ... (30 returned values)

***SEC <Addr>** Secondary Address

<Addr>	Parameter description	Def. value	Default unit	FW vers.
0 to 29	Secondary address	0	–	V1.20

Command description

This command has no query form. It switches over to the specified secondary address. It is required if the serial interface is used for remote control (software switchover, RS-232 remote interface, see previous command and section *Setting the Device Address* in chapter 5).

Subsystem Communicate

The *COMMunicate* subsystem contains the commands for configuration of the remote serial interfaces. It corresponds to the *Communicate* tab in the *Setup* menu opened via the *SETUP* key on the front panel. The parameters set in this subsystem are explained in more detail in chapter 8, section *Hardware Interfaces*.

SYSTem:COMMunicate:GPIB[:SELF]:ADDRess *<Addr>* Primary Address

<Addr>	Parameter description	Def. value	Default unit	FW vers.
0 to 30	Primary address to the GPIB (IEEE) bus	20	–	V1.20

Command description

This command sets the primary address of the GPIB driver which is used to address the device (CMU).

It is equivalent to `SYSTem:REMote:ADDRess:PRIMary` (see above).

SYSTem:COMMunicate:SERial<1|2>:APPLication? Application

Response	Parameter description	Def. value	Default unit	FW vers.
TRAN | **REM |** **PRIN**	Transfer Remote control Printer control (future extension)	dep. on SCPI connection (port) and printer settings	-	V1.20

Command description

This command is always a query. It returns the current application (connection) of the serial (RS-232) interface. The numeric suffix distinguishes the two interfaces COM 1 and COM 2.

SYSTem:COMMunicate:SERial<1|2>[:RECeive]:BAUD *<Baudrate>* Baud Rate

<Baudrate>	Parameter description	Def. value	Default unit	FW vers.
110 | 300 | 600 | 1200 | 2400 | 4800 | 9600 | 19200 | 38400 | 57600 | 115200	baud rate	9600	baud	V1.20

Command description

This command sets the baud rate of the serial interface no. 1 or 2 (connectors COM 1 or COM 2). If a COM port is selected as an GPIB connector, the default transmission rate is 19200 baud.

SYSTem:COMMunicate:SERial<1|2>[:RECeive]:BITs *<DataBits>* Data Bits

<DataBits>	Parameter description	Def. value	Default unit	FW vers.
7 | 8	number of data bits	8	–	V1.20

Command description

This command sets the number of data bits of the serial interface no. 1 or 2 (connectors COM 1 or COM 2). The sum of data bits and stop bits must be equal to 9.

SYSTem:COMMunicate:SERial<1|2>[:RECeive]:STOP *<StopBits>* Stop bits

<StopBits>	Parameter description	Def. value	Default unit	FW vers.
1 | 2	number of stop bits	1	-	V1.20

Command description

This command sets the number of stop bits of the serial interface no. 1 or 2 (connectors COM 1 or COM 2). The sum of data bits and stop bits must be equal to 9.

SYSTem:COMMunicate:SERial<1|2>[:RECeive]:PARity[:TYPE] *<Parity>* Parity

<Parity>	Parameter description	Def. value	Default unit	FW vers.
NONE	no parity	NONE	–	V1.20
ODD	odd parity			
EVEN	even parity			

Command description

This command sets the parity of the serial interface no. 1 or 2 (connectors COM 1 or COM 2).

SYSTem:COMMunicate:SERial<1|2>:TRANsmit:PACE *<Pace>* Transmission Protocol

<Pace>	Parameter description	Def. value	Default unit	FW vers.
XON	Xon/Xoff – protocol	XON	–	V1.20
ACK	Hardware protocol with CTS/RTS lines			
NONE	No protocol set			

Command description

This command sets the handshake protocol of the serial interface no. 1 or 2 (connectors COM 1 or COM 2)

Subsystem Options

The *Options* subsystem contains the commands for querying information on the instrument and the available options. It corresponds to the *Options* tab in the *Setup* menu opened via the *SETUP* key on the front panel.

SYSTem:OPTions:INFO? Device Info

Response	Def. value	Default unit	FW vers.
Example: ROHDE&SCHWARZ,CMU 200,840675/018,V1.17B 1998-11-30	–	–	V1.20

Command description

This command returns the information on the device comprising the manufacturer, model, serial number and base system firmware version. This command is always a query and is equivalent to the common command `*IDN?`

SYSTem:OPTions? Options

Response	Parameter description	Def. value	Def. unit	FW vers.
HWO, **"B11/12","B11",** **"B17",NAN,** **"B21","available",...**	Identifier for hardware options 1st option, 2nd option, not available. 3rd option, available	–	–	V1.20
SWO, **"K0",NAN,** **"K20","enabled",** **"K21","3x10.c05 available",**	Identifier for software options 1st option, not available 2nd option, enabled 3rd option, available but not enabled			
HWE, **"CPU(FMR)", "FMR5" ...**	Identifier for hardware equipment 1st equipment ...			
FWV, **„uP1","V7.00 26.08.02",** **"uP2",NAN**	Identifier for firmware versions 1st option, 2nd option, 3, 4 ...			

Command description

This command returns a list of all options and equipment available in the instrument, equivalent to the list overview in the *Setup – Options* tab. It is always a query. An alternative list of options (following IEEE 488.2 conventions) can be queried via the common command *OPT?

Subsystem Time

The *Time* subsystem contains the commands for the current time and date. It corresponds to the *Time* tab in the *Setup* menu opened via the *SETUP* key on the front panel.

SYSTem:TZONe *<Hour>[,<Minute>]* or
SYSTem:TIMe:TZONe *<Hour>[,<Minute>]* Time Zone

Parameters	Parameter description	Def. value	Default unit	FW vers.
<Hour> **<Minute>**	integer value between –12 and +12 -59 to +59 (optional)	+1 0	–	V1.20

Command description

This command defines the time zone via the time offset from Greenwich mean time. A time offset of +1 h (default setting) corresponds to Middle European time.

SYSTem:TIMe[:TIMe] *<Hour>,<Minute>,<Second>* or
SYSTem:TIMe *<Hour>,<Minute>,<Second>* Current Time

Parameters	Parameter description	Def. value	Default unit	FW vers.
<Hour>, **<Minute>,** **<Second>**	Hours (0 to 23) Minutes (0 to 59) Seconds (0 to 59)	– – –	h min s	V 1.20

Command description

This command sets the internal system time of the CMU.

SYSTem:TIMe:DATe <*Year*>,<*Month*>,<*Day*> or
SYSTem:DATE <*Year*>,<*Month*>,<*Day*> Date

Parameters	Parameter description	Def. value	Default unit	FW vers.
<Year>,	Four-digit year (1980 to 2099)	–	–	V1.20
<Month>,	Month (1 to 12)	–		
<Day>	Day (1 to 31)	–		

Command description

This command sets the internal system date of the CMU.

Subsystem MISC

The *MISC* subsystem sets the acoustic signal and selecting the external keyboard assignment. It corresponds to the *Misc.* tab in the *Setup* menu opened via the *SETUP* key on the front panel

SYSTem:MISC:KBEep <*Enable*> Key Beep

<Enable>	Parameter description	Def. value	Default unit	FW vers.
ON |	Key beep on	OFF	–	V1.20
OFF	Key beep off			

Command description

This command switches the acoustic signal of the CMU on or off.

SYSTem:MISC:KEYBoard <*Country*> Keyboard

<Country>	Parameter description	Def. value	Default unit	FW vers.
US |	American keyboard	US	–	V1.20
GR	German keyboard			

Command description

This command selects the driver for the external keyboard.

Subsystem GTRMode (Local to Remote Switchover)

The *GTRMode* subsystem determines the behavior of the CMU in a local to remote transition. The settings are provided in the *Remote* tab of the *Setup* menu.

SYSTem:GTRMode:COMPatible *<Enable>* Local to Remote

<Enable>	Parameter description	Def. value	Default unit	FW vers.
ON |	Connection or call dropped on local to remote switchover/ generator switched off	ON	–	V3.05
OFF	Current signalling state or generator state maintained			

Command description

This command defines the behavior of the CMU in a local to remote transition. The command is valid for all function groups and test modes, however, its effect depends on the test mode *(Signalling* or *Non Signalling* tests):

Signalling	In the *ON* setting, the connection or call is dropped and the CMU returns to its default signalling state (e.g. *SOFF* in the *GSMxxx-MS* function groups). In the *OFF* setting, all signalling states are maintained. This makes it possible to switch the instrument to remote control without dropping a call or connection. See also operating manuals for the different network tests.
Non Signalling	In the *ON* setting, all generators are switched off. In the *OFF* setting, the current operating state of all generators is maintained.

***GTL** Go to Local

Command description

This command has no query form. It switches the instrument immediately back to local mode (manual control). The CMU opens the menu of the current running measurement; see also section *Return to Manual Control* in Chapter 5. This command can be used instead of the addressed command GTL is a serial connection is used.

Subsystem MQUeue

The *MQUeue* subsystem contains the commands for symbolic measurement ready evaluation. These commands are used to query the contents of the measurement queue. To activate the measurement queue, event reporting must not be switched off; see section *Event Reporting* in chapter 5.

SYSTem:MQUeue[:COMPlete][:LIST]? Complete Measurement Queue

Response	Parameter description	Def. value	Default unit	FW vers.
<FGroup_Mode>, **<MeasObject>, ...**	Function group and test mode Ready measurement	"NONE", "NONE"	–	V2.10

Command description

This command is always a query. It returns and deletes the contents of the complete measurement queue. The individual results are returned in chronological order (first in first out). Examples of possible responses are:

"RF_NSig","POWer","RF_NSig","SPECtrum"
Power and spectrum measurement ready in function group *RF*,
Test mode *Non Signalling*

"NONE", "NONE"
No ready measurements reported

SYSTem:MQUeue[:COMPlete]:ITEM?				Next Entry in Measurement Queue
Response	Parameter description	Def. value	Default unit	FW vers.
<FGroup_Mode>, **<MeasObject>**	Function group and test mode Ready measurement	"NONE", "NONE"	–	V2.10
Command description				
This command is always a query. It returns and deletes the oldest ready measurement in the measurement queue.				

Reset of Function Groups

The [illegible] subsystem restores the (factory) default values for all instrument settings. It corresponds to the *Reset* menu opened via the *RESET* key on the front panel.

SYSTem:PRESet[:ALL] **SYSTem:RESet[:ALL]**	Reset all function groups and test modes
Command description	FW vers.
This command sets all parameters of the instrument to default values. The commands differ for instrument settings with distinct default values in manual and remote control (e.g. the repetition mode for many measurements): • [illegible] restores the default values for manual control, leaving the current remote control parameters unchanged. • [illegible] (available for FW vers. ≥3.10) restores the default values for remote control leaving the current manual control parameters unchanged. This command is equivalent to `*RST`.	V1.20

SYSTem:RESet:CURRent	Partial Reset
Command description	FW vers.
This command sets all parameters of the current function group and test mode to default values. The command is available in all function groups. In contrast to the *Reset* menu the command restores the default values defined for remote control operation. In cases where remote and manual control use distinct settings (e.g. the repetition mode for many measurements), the manual control settings are left unchanged.	V3.10

Remote Report – Subsystem TRACe

The `TRACe` subsystem determines whether the remote report is displayed on screen or written to a file. It corresponds to the *Report...* hotkeys on the bottom of the *Remote* screen.

LLO *<Boolean> Local Lockout

<Boolean>	Parameter description	Def. value	Default unit	FW vers.
FALSe | **TRUE**	Hitting any front panel key switches to manual control Front panel keys locked	FALSe	–	V3.10

Command description

This command has no query form. It locks the front panel keys to prevent an inadvertent switchover to manual control. If TRUE is set, the hotkeys to control the remote screen are still active. The parameter FALSe re-activates all front panel keys for switchover to manual control.

This command can be used instead of the universal command LLO is a serial connection is used.

TRACe:REMote:MODE:DISPlay *<Enable>* Report Display

<Enable>	Parameter description	Def. value	Default unit	FW vers.
ON | **OFF**	Remote report displayed on screen Remote report not displayed	OFF	–	V3.05

Command description

This command qualifies whether the remote report is displayed on screen.

TRACe:REMote:MODE:FILE *<Enable>* Report File

<Enable>	Parameter description	Def. value	Default unit	FW vers.
ON | **OFF**	Remote report stored Remote report not stored	OFF	–	V3.05

Command description

This command qualifies whether the remote report is written to a file named Remote.trc in the root directory of the internal hard disk.

TRACe:REMote:MODE:ERRor *<Enable>* Show/Hide Error Messages

<Enable>	Parameter description	Def. value	Default unit	FW vers.
ON | OFF	Show or hide error messages	ON	–	V3.08

Command description

This command qualifies whether error messages (marked by a "E !" symbol on a red square) are included in the remote report.

TRACe:REMote:MODE:SQR *<Enable>* Show/Hide Service Requests

<Enable>	Parameter description	Def. value	Default unit	FW vers.
ON | OFF	Show or hide SRQs	OFF	–	V3.08

Command description

This command qualifies whether a message is written to the remote report whenever the CMU sends a service request to the controller. The message symbolizes the contents of the status byte (e.g. ERR, OPR, MAV, OPER,...) and is marked by a red "S" symbol.

TRACe:REMote:MODE:OUTLines *<Enable>*				Report Lines for Output
<Enable>	Parameter description	Def. value	Default unit	FW vers.
1 to 4	Maximum number of lines	4	–	V3.08
Command description				
This command defines the maximum number of lines available for each output string in the remote report screen. If the output string of a query (e.g. [illegible] in the RF function group) is longer than the specified number of lines, it is truncated and the last three characters are replaced by "...".				

File Manager – System MMEMory

The MMEMory system provides mass storage capabilities for the CMU. Part of the functionality of this system is included in the *Data* menu.

The mass storage of the CMU may be internal or external. The internal mass storage device is a section on the internal hard disk that is reserved for mass storage (directory c:\temp). The external mass storage device is either a floppy disk or a PCMCIA memory card, depending on the instrument configuration. The *<msus>* (mass storage unit specifier) parameter in the MMEMory commands denotes the root directory of the *INTernal* or *EXTernal* mass storage device.

The <FileName> parameter is a string. The contents of the string may contain characters for specifying subdirectories, e.g. "\TEMP\TRASH\test.txt" for the file named *test.txt* in the *TEMP\TRASH* subdirectory of the root directory or "TEMP\TRASH\test.txt" for the file named *test.txt* in the *TEMP\TRASH* subdirectory of the current directory, to be queried with [illegible]. The file name itself may contain the period as a separator for extensions.

Unless otherwise stated, all the following commands are SCPI-confirmed.

MMEMory:INFO? *<FileName> [,<msus>]*				View Info
<FileName>	Parameter description	Def. value	Def. unit	
"<8 dig.max>.<3dig.>"	Name of the file to be inquired in DOS (8.3) convention.	–	–	
<msus>	Parameter description	Def. value	Def. unit	
INTernal | EXTernal	Internal memory (hard disk) External memory (floppy disk or PCMCIA memory card)	INTernal[5]	–	
Returned info	Parameter description	Def. value	Def. unit	FW vers.
<Year>,<Month>,<Day>,	Date when the file was stored	–	y, m, d	V3.05
<Hour>,<Min>,<Sec>,	Time when the file was stored	–	h, min, s	
<Size>,	File size in byte	–	byte	
<Version>,	File version number	" "	–	
"<Comment>"	Comment string stored with the file	" "	–	

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[5] See MMEMory:MSIS *[<msus>]* setting.

Description of command

This command retrieves information about a file stored on the external or internal mass memory. The <msus> parameter must be specified if information on an external file is needed and the internal memory contains a file of the same name. Alternatively, *msus* may be specified with the command *MMEMory:MSIS [<msus>].*

This command is CMU-specific. The <Version> and <Comment> output parameters are reserved for future extensions.

MMEMory:COMMent *<Comment>*

<Comment>	Parameter description	Def. value	Def. unit	FW vers.
"<160 characters max.>"	Comment string	" "	–	V3.10

Description of command

This command defines a comment for a CMU configuration file. The comment is saved to the file generated via `MMEMory:SAVE[:ALL] <FileName>[,<msus>]` or `MMEMory:SAVE:CURRent <FileName>[,<msus>]`. The command is CMU-specific.

MMEMory:MSIS *[<msus>]* Internal/External

<msus>	Parameter description	Def. value	Def. unit	FW vers.
INTernal | **EXTernal**	Internal memory (hard disk) External memory (floppy disk or PCMCIA memory card)	INTernal	–	V3.05

Description of command

This *Mass Storage IS* command resets the default mass storage parameter <*msus*> for all `MMEmory` commands.

MMEMory:DIRectory[:CURRent]? Current Directory

Returned value	Parameter description	Def. value	Def. unit	FW vers.
INT | EXT, **"<DirectoryName>"**	Internal or external storage device Name and path of the current directory in DOS convention.	INT[6] "\USERDATA\SAVE"	–	V3.05

Description of command

This command is always a query and returns the current directory name and path. Possible return strings are INT, " " (for the internal root directory) or EXT, "\TEMP\TRASH" (for the \TEMP\TRASH subdirectory of the external root directory). This command is CMU-specific.

The current directory is set to default when the base system is booted but left unchanged when the base system is reset (`*RST, SYSTem:RESet:CURRent`).

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[6] See MMEMory:MSIS *[<msus>]* setting.

MMEMory:CDIRectory ***[<DirName>], [<msus>]*** Change Directory

<DirName>	Parameter description	Def. value	Def. unit	FW vers.
"<DirectoryName>",	Name of the directory to be accessed	"\USERDATA\SAVE"	–	V3.05
INTernal | EXTernal	Internal or external storage device			

Description of command

This command has no query form. It sets the directory specified via *<DirName>* as default directory. If this parameter is omitted, the directory is set to the USERDATA\SAVE subdirectory of the INTernal or EXTernal root directory, depending on the current *MMEMory:MSIS [<msus>]* settings.

MMEMory:DELete ***<FileName> [,<msus>]*** Delete File

Parameters	Parameter description	Def. value	Def. unit	FW vers.
"<FileName>",	Name of the file to be deleted	–	–	V3.05
INTernal | EXTernal	Storage device of the file to be deleted	INTernal[6]	–	

Description of command

This command has no query form. It removes a single file from the specified mass storage device.

MMEMory:RMDir ***<DirName> [,<msus>]*** Remove Directory

Parameters	Parameter description	Def. value	Def. unit	FW vers.
"<DirectoryName>",	Name of the directory to be removed	–	–	V3.05
INTernal | EXTernal	Storage device of the directory	INTernal[6]	–	

Description of command

This command has no query form. It removes a directory with all its contents and subdirectories from the specified mass storage device. The command is CMU-specific.

MMEMory:MKDir ***<DirName> [,<msus>]*** Make Directory

Parameters	Parameter description	Def. value	Def. unit	FW vers.
"<DirectoryName>",	Name of the directory to be created	–	–	V3.05
INTernal | EXTernal	Storage device of the directory	INTernal[6]	–	

Description of command

This command has no query form. It creates a new subdirectory in the current directory. The command is CMU-specific.

MMEMory:COPY Copy File
<FileSource>, <msus1>, <FileDest>, <msus2> | <FileSource>, <FileDest>

Parameters	Parameter description	Def. value	Def. unit	FW vers.
"<FileSource>",	Name of the file to be copied	–	–	V3.05
INTernal | EXTernal,	Storage device of the source file	INTernal[6]	–	
"<FileDest>",	Name of the new file	–	–	
INTernal | EXTernal	Storage device of the new file	INTernal[6]	–	

Description of command

This command has no query form. It copies the contents of an existing file or directory to a new one.

MMEMory:MOVE *<FileSource>, <msus1>, <FileDest>, <msus2> | <FileSource>, <FileDest>*				Move File
Parameters	Parameter description	Def. value	Def. unit	FW vers.
"<FileSource>",	Name of the file to be renamed	–	–	V3.05
INTernal | EXTernal,	Storage device of the source file	INTernal[6]	–	
"<FileDest>",	Name of the new file	–	–	
INTernal | EXTernal	Storage device of the new file	INTernal[6]	–	
Description of command				
This command has no query form. It moves an existing file to another file name and mass storage device.				

MMEMory:REName *<FileSource>, <FileDest> [,<msus>]*				Rename File
Parameters	Parameter description	Def. value	Def. unit	FW vers.
"<FileSource>",	Name of the file to be renamed	–	–	V3.10
INTernal | EXTernal,	Storage device of the source file	INTernal[6]	–	
"<FileDest>",	Name of the new file	–	–	
INTernal | EXTernal	Storage device of the new file	INTernal[6]	–	
Description of command				
This command has no query form. It renames an existing file. This command is CMU-specific.				

MMEMory:SCAN?				Scan Disk
Rückgabe	Parameter description	Def. value	Def. unit	FW vers.
INT | EXT,	Storage device	–	–	V3.05
D , "<SubdirectoryName1>", "<SubdirectoryName2>", … ,	List of subdirectory names			
F , "<FileName1>", "<FileName2>", … ,	List of file names			
Description of command				
This command is always a query and lists the contents of the current directory. Subdirectories and files are listed in alphabetical order. The first entry specifies the mass storage device (internal or external), entries after "D" denote the subdirectories, entries after "F" denote the files. This command is CMU-specific.				

MMEMory:DATA *<FileName> ,<Data>* Transfer Data

Parameters	Parameter description	Def. value	Def. unit	
"<FileName>",	Name of the destination file	–	–	
<Data>	Data to be transferred to the CMU	–	–	
Parameters for query	**Parameter description**	**Def. value**	**Def. unit**	**FW vers.**
"<FileName>"	Name of the source file	–	–	V3.05

Description of command

This command loads [illegible] from the controller into the file [illegible] stored in the current directory of the current CMU mass storage device [illegible] is in 488.2 block format. The data may be transferred via GPIB bus or via serial interface.

The query form is [illegible] with the response being the associated [illegible] in block format. In this form the command transfers data from the current CMU mass storage device to the controller.

Instead of the entire data transferred the remote protocol contains a string indicating the length of the block data in bytes, e.g. `<DEF BLOCK (Length = 19)>`.

MMEMory:SAVE[:ALL] *<FileName> [,<msus>]* Save all configurations

Parameters	Parameter description	Def. value	Def. unit	FW vers.
"<FileName>",	Name of the config. file to be created	–	–	V3.10
INTernal | EXTernal	Storage device of the config. file	INTernal	–	

Command description

This command saves the configuration of all function groups and test modes to a single configuration file. A "?" in the specified file name will be replaced by current numbers that are automatically incremented, starting with zero. The auto-increment function overwrites an existing file with a "9" in its file name. For instrument settings that may be different in manual and remote control (e.g. the repetition mode for many measurements) the manual setting is saved. This command is CMU-specific.

MMEMory:SAVE:CURRent *<FileName> [,<msus>]*

Save configurations in current function group and test mode

Parameters	Parameter description	Def. value	Def. unit	FW vers.
"<FileName>",	Name of the config. file to be created	–	–	V3.10
INTernal | EXTernal	Storage device of the config. file	INTernal	–	

Command description

This command saves the configuration of the current function group and test mode to a configuration file. A "?" in the specified file name will be replaced by current numbers that are automatically incremented, starting with zero. The auto-increment function overwrites an existing file with a "9" in its file name. For instrument settings that may be different in manual and remote control (e.g. the repetition mode for many measurements) the manual setting is saved. The command is available in all function groups. This command is CMU-specific.

MMEMory:RECall[:ALL] *<FileName> [,<msus>]* Recall all configurations

Parameters	Parameter description	Def. value	Def. unit	FW vers.
"<FileName>",	Name of the config. file to be recalled	–	–	V3.10
INTernal | EXTernal	Storage device of the config. file	INTernal	–	

Command description

This command recalls the configuration of all function groups and test modes stored in a configuration file. This command is CMU-specific.

MMEMory:RECall:CURRent *<FileName> [,<msus>]*

Recall configurations in current function group and test mode

Parameters	Parameter description	Def. value	Def. unit	FW vers.
"<FileName>",	Name of the config. file to be recalled	–	–	V3.10
INTernal | EXTernal	Storage device of the config. file	INTernal	–	

Command description

This command recalls the configuration of the current function group and test mode from a configuration file. The command is available in all function groups. This command is CMU-specific.

Synchronization

The *Synchronize* subsystem contains the commands for configuring the reference frequency. It corresponds to the *Reference Frequency* softkey in the *Sync.* tab of the *Connection Control* menu. Note that this tab is available in every function group

CONFigure:SYNChronize:FREQuency:REFerence *<Frequency>*

Reference Frequency

<Frequency>	Parameter description	Def. value	Default unit	FW vers.
10 kHz to 52 MHz	Reference frequency	10 MHz	Hz	V1.12

Command description

The command defines the frequency of the synchronization signal.

CONFigure:SYNChronize:FREQuency:REFerence:MODE *<Mode>*

Ref. Frequency Source

<Mode>	Parameter description	Def. value	Default unit	FW vers.
INTernal |	Internal reference frequency used	INT	–	V1.12
EXTernal	External reference frequency used			

Command description

The command defines the source of the synchronization signal. After activating the external reference frequency (e.g. after a reset of the base system where the reference frequency is set to `INTernal`) it is necessary to allow for a setting time (~1 s) until the CMU has synchronized. The query `[SENSe:]SYNChronize:FREQuency:REFerence:LOCKed?` indicates whether the reference frequency is locked. A partial reset of all function groups with the exception of the base system does not reset the source of the reference frequency.

[SENSe:]SYNChronize:FREQuency:REFerence:LOCKed?

Ref. Frequency Not Locked

Response	Parameter description	Def. value	Def. unit	FW vers.
ON |	Synchronization to reference frequency achieved	–	–	V3.10
OFF	Synchronization to reference frequency failed			

Command description

This command is always a query. It indicates whether the CMU is synchronized to the (external) reference frequency.

Note: *After activating the external reference frequency (command `CONFigure:SYNChronize:FREQuency:REFerence:MODE EXTernal`) it is necessary to allow for a setting time (~1 s) until the CMU has synchronized. In this case it is recommended to check whether the reference frequency is locked before starting a measurement in remote control mode.*

[SENSe:]SYNChronize:FREQuency:REFerence:LOCKed? Ref Frequency Not Locked

Response	Parameter description	Def. value	Def. unit	FW vers.
ON | OFF	Synchronization to reference frequency achieved Synchronization to reference frequency failed	–	–	V3.10

Command description

This command is always a query. It indicates whether the CMU is synchronized to the (external) reference frequency.

Note: *After activating the external reference frequency (command* `CONFigure:SYNChronize:FREQuency:REFerence:MODE EXTernal`*) it is necessary to allow for a setting time (~1 s) until the CMU has synchronized. In this case it is recommended to check whether the reference frequency is locked before starting a measurement in remote control mode.*

RF Measurements

The commands listed in this chapter belong to the *RF* function group.

Subsystem Options

The *Options* subsystem contains the commands for querying information on the instrument and the available options. It corresponds to the *Options* tab in the *Setup* menu opened via the *SETUP* key on the front panel.

SYSTem:OPTions:INFO:CURRent? Device Info

Response		Def. value	Default unit	FW vers.
Example:	Rohde&Schwarz,CMU 200-1100.0008.02,840675/018, V3.10C:SP02 2002-09-05"RF_NSig"	–	–	V3.10

Command description

This command returns the information on the device comprising the manufacturer, model, serial number and firmware version of the current function group. This command is always a query.

Configuration File Management – System MMEMory

The `MMEMory` system provides mass storage capabilities for the CMU. The functionality of this system is included in the *Data* menu; see CMU200/300 operating manual.

The mass storage of the CMU may be internal or external. The internal mass storage device is a section on the internal hard disk that is reserved for mass storage (directory c:\temp). The external mass storage device is either a floppy disk or a PCMCIA memory card, depending on the instrument configuration. The <*msus*> (mass storage unit specifier) parameter in the `MMEMory` commands denotes the root directory of the *INTernal* or *EXTernal* mass storage device.

The <FileName> parameter is a string. The contents of the string may contain characters for specifying subdirectories, e.g. "\TEMP\TRASH\test.txt" for the file named *test.txt* in the *TEMP\TRASH* subdirectory of the root directory or "TEMP\TRASH\test.txt" for the file named *test.txt* in the *TEMP\TRASH* subdirectory of the current directory, to be queried with the base system command `MMEMory:DIRectory [:CURRent]?`. The file name itself may contain the period as a separator for extensions.

MMEMory:SAVE:CURRent *<FileName> [,<msus>]*

Save configurations in current function group and test mode

Parameters	Parameter description	Def. value	Def. unit	FW vers.
"<FileName>",	Name of the config. file to be created	–	–	V3.10
INTernal | EXTernal	Storage device of the config. file	INTernal	–	

Command description

This command saves the configuration of the current function group and test mode to a configuration file. A "?" in the specified file name will be replaced by current numbers that are automatically incremented, starting with zero. The auto-increment function overwrites an existing file with a "9" in its file name. For instrument settings that may be different in manual and remote control (e.g. the repetition mode for many measurements) the manual setting is saved. The command is available in all function groups. This command is CMU-specific.

MMEMory:RECall:CURRent ***<FileName> [,<msus>]***

Recall configurations in current function group and test mode

Parameters	Parameter description	Def. value	Def. unit	FW vers.
"<FileName>",	Name of the config. file to be recalled	–	–	V3.10
INTernal | EXTernal	Storage device of the config. file	INTernal	–	

Command description

This command recalls the configuration of the current function group and test mode from a configuration file The command is available in all function groups. This command is CMU-specific.

Partial Reset

The [illegible] subsystem restores the (factory) default values for the current function group and test mode. It is similar to the *Reset* menu opened via the *RESET* key on the front panel.

SYSTem:RESet:CURRent

Partial Reset

Command description	FW vers.
This command sets all parameters of the current function group and test mode to default values The command is available in all function groups In contrast to the *Reset* menu the command restores the default values defined for remote control operation In cases where remote and manual control use distinct settings (e g the repetition mode for many measurements), the manual control settings are left unchanged.	V3 10

Connection Control

The remote-control commands presented in this section provide settings that are valid for all measurements in the *RF* function group. They correspond to the settings in the *Connection Control* popup menu (see chapter 3 and 4).

Subsystem LEVel (Input Level)

The subsystem *LEVel* controls the level in the RF input signal path. It corresponds to the table section *Input Level* in the *Analyzer* tab of the *Connection Control* menu and the *Analyzer Level – Reference* hotkey in the *Spectrum* menu.

[SENSe:]LEVel:MAXimum ***<Level>***

Max. Level

<Level>	Parameter description	Def. value	Default unit	FW vers.
0 dBm to +53 dBm	Max. input level for RF 1	0.0	dBm	V1.15
–14 dBm to 39 dBm	Max. input level for RF 2	0.0		
–37 dBm to 0 dBm	Max. input level for RF 4 IN	0.0		

Command description

This command defines the expected maximum input level for *Power* measurements and sets the input measurement path accordingly. The value range depends on the used RF input and the external attenuation.

[SENSe:]LEVel:ATTenuation <*Mode*> Attenuation

<Mode>	Parameter description	Def. value	Default unit	FW vers.
NORMal |	Normal	NORMal	–	V1.15
LNOise |	Low noise (level at mixer 10 dB higher than in normal setting)			
LDIStortion	Low distortion factor (level at mixer 10 dB lower than in normal setting)			

Command description

This command defines the attenuation or gain of the input measurement path.

[SENSe:]LEVel:MODE <*Mode*> Input level – Mode

<Mode>	Description of parameters	Def. value	Def. unit	FW vers.
MANual |	Manual setting	AUT	-	
AUTomatic	Automatic setting corresponding to average power of signal applied			

Description of command

This command defines the mode for setting the maximum input level.

[SENSe:]LEVel:REFerence <*Level*> Reference Level for Spectrum

<Level>	Parameter description	Def. value	Default unit	FW vers.
–100 dBm to +53 dBm	Reference level for RF 1	+30	dBm	V1.20
–100 dBm to +39 dBm	Reference level for RF 2	+30		
–100 dBm to 0 dBm	Reference level for RF 4 IN	0.0		

Command description

This command defines the reference level for *Spectrum* measurements.

[SENSe:]LEVel:DEFault <*Enable*> Default Settings

<Enable>	Description of parameters	Def. value	Def. unit	FW vers.
ON |	The parameters are set to their default values	ON	–	V1.15
OFF	All or some parameters differ from the default values			

Description of command

If used as a setting command with the parameter *ON* this command sets all parameters of the subsystem to their default values (the setting *OFF* has no effect).

If used as a query the command returns whether all parameters are set to their default values *(ON)* or not *(OFF)*.

Subsystem TRIGger (Trigger Mode)

The subsystem *TRIGger* determines the trigger mode. It corresponds to the table section *Trigger* in the *Analyzer* tab of the *Connection Control* menu and the *Analyzer Level – Trigger...* hotkeys in the *Spectrum* or *Power* menu.

TRIGger[:SEQuence]:SOURce <*Source*> Source

<*Source*>	Parameter description	Def. value	Default unit	FW vers.
IMMediate |	Free run, continuous measurement (without reference to input signal)	IMM	–	V1.15
RFPower |	The RF signal controls triggering depending on the trigger level `(TRIG:SEQ:THR)`			
IFPower |	The IF signal controls triggering depending on the trigger level `(TRIG:SEQ:THR)`			
EXTern	External triggering (via connector AUX3)			

Command description

This command determines the trigger source.

TRIGger[:SEQuence]:THReshold:RFPower <*Threshold*> Level – RF Power

<*Threshold*>	Parameter description	Def. value	Default unit	FW vers.
LOW |	Low trigger threshold (*RF Max. Level* – 26 dB)	MEDium	–	V3.10
MEDium |	Medium trigger threshold (*RF Max. Level* – 16 dB)			
HIGH	High trigger threshold (*RF Max. Level* – 6 dB)			

Command description

This command sets the RF input signal level at which the measurement is triggered relative to the maximum RF input level, see `[SENSe:]LEVel:MAXimum`. The setting has effect for trigger source `RFPower` only (see `TRIG:SEQ:SOUR`).

TRIGger[:SEQuence]:THReshold:IFPower <*Threshold*> Level – IF Power

<*Threshold*>	Parameter description	Def. value	Default unit	FW vers.
–47 dB to 0 dB	IF power threshold	–26	dB	V3.10

Command description

This command sets the IF signal level at which the measurement is triggered. The IF power threshold is defined relative to the maximum RF input level, see `[SENSe:]LEVel:MAXimum`. The setting has effect for trigger source `IFPower` only (see `TRIG:SEQ:SOUR`).

TRIGger[:SEQuence]:SLOPe <*Slope*> Slope

<*Slope*>	Parameter description	Def. value	Default unit	FW vers.
POSitive |	Rising slope	POS	–	V1.15
NEGative	Falling slope			

Command description

This command qualifies whether the trigger event occurs on the *Rising Edge* or on the *Falling Edge* of the trigger signal. The setting has no influence on free run measurements (trigger source `IMMediate`).

TRIGger[:SEQuence]:SOURce:EXTernal <*Source*>				Ext. Trigger (AUX 3/4)
<Source>	Description of parameters	Def. value	Def. unit	FW vers.
PIN6 | PIN7 | PIN8	Pin for external trigger signal	PIN8	–	V3.10

Description of command

This command determines the pins on the AUX 3 or AUX4 connectors used for the external trigger signal. The setting only has effect if the trigger source is an *External* signal.

TRIGger[:SEQuence]:DEFault <*Enable*>				Default Settings
<Enable>	Description of parameters	Def. value	Def. unit	FW vers.
ON |	The parameters are set to their default values	ON	–	V1.15
OFF	All or some parameters differ from the default values			

Description of command

If used as a setting command with the parameter *ON* this command sets all parameters of the subsystem to their default values (the setting *OFF* has no effect).

If used as a query the command returns whether all parameters are set to their default values *(ON)* or not *(OFF)*.

Subsystem RFANalyzer... (Analyzer Settings)

The subsystem *RFANalyzer...* sets the RF analyzer to a definite frequency and bandwidth. The settings correspond to the *Analyzer Settings* in the *Analyzer/Generator* menu.

[SENSe:]RFANalyzer:FREQuency *<Frequency>* Frequency

<Frequency>	Parameter description	Def. value	Default unit	FW vers.
50 kHz to 2.7 GHz	Frequency (0.1 Hz resolution)	1000 MHz	Hz	V1.15

Command description

This command defines the input frequency of the analyzer. The usable frequency range exceeds the specified range, see data sheet.

[SENSe:]RFANalyzer:BANDwidth[:RESolution] *<Bandwidth>* [SENSe:]RFANalyzer:BWIDth[:RESolution] *<Bandwidth>* Bandwidth

<Bandwidth>	Parameter description	Def. value	Default unit	FW vers.
10 Hz to 1 MHz | WIDE	Bandwidths of the analyzer (the values are rounded in the steps 1 | 2 | 3 | 5)	WIDE	–	V1.15

Command description

This command defines the bandwidth of the analyzer. If WIDE is set no restriction is placed on the input frequency.

Measurement Control – Subsystem RFANalyzer

The subsystem *RFANalyzer* controls the RF analyzer. The subsystem corresponds to the *Analyzer Power* softkey in the *Analyzer/Generator* menu.

INITiate:RFANalyzer	Start new measurement	*⇒ RUN*
ABORt:RFANalyzer	Abort running measurement and switch off	*⇒ OFF*
STOP:RFANalyzer	Stop measurement after current evaluation period	*⇒ STOP*
CONTinue:RFANalyzer	Next measurement step (only *stepping mode*)	*⇒ RUN*

Command description	FW vers.
These commands have no query form. They start or stop the measurement, setting it to the status indicated in the top right column.	V1.15

CONFigure:RFANalyzer:EREPorting <*Mode*> Event Reporting

<Mode>	Parameter description	Def. value	Def. unit	FW vers.
SRQ |	Service request	OFF	–	V1.15
SOPC |	Single operation complete			
SRSQ |	SRQ and SRSQ			
OFF	No reporting			

Command description

This command defines the events generated when the measurement is terminated or stopped *(event reporting,* see chapter 5).

FETCh:RFANalyzer:STATus? Measurement status

Returned value	Parameter description	Def. value	Def. unit	FW vers.
OFF |	Measurement in the *OFF* state (`*RST` or `ABORt`)	OFF	–	V1.15
RUN |	Running (after `INITiate, CONTinue` or `READ`)			
STOP |	Stopped (`STOP`)			
ERR |	*OFF* (could not be started)			
STEP |	Stepping mode *(<stepmode>=STEP)*			
RDY,	Stopped according to repetition mode and stop condition			
1 to 10000 |	Counter for current evaluation period			
NONE,	Counter not used	NONE	–	

Command description

This command is always a query. It returns the status of the measurement (see chapters 3 and 5).

Subsystem RFANalyzer:CONTrol

The subsystem *RFANalyzer:CONTrol* defines the repetition mode of the RF analyzer. This subsystem has no equivalent in manual control.

CONFigure:RFANalyzer:CONTrol:REPetition *<Repetition>* ,*<StopCondition>*,*<Stepmode>*

Test cycles

<Repetition>	Parameter description	Def value	Def unit	
CONTinuous | **SINGleshot |** **1 to 10000**	Continuous measurement (until `STOP` or `ABORT`) Single shot measurement (until `Status = RDY`) Multiple measurement (*counting*, until `Status = STEP | RDY`)	SING	–	
<StopCondition>	Parameter description	Def value	Def unit	
NONE	Continue measurement even in case of error	NONE	–	
<Stepmode>	Description of parameters	Def value	Def. unit	FW vers.
STEP | **NONE**	Interrupt measurement after each statistics cycle Continue measurement according to its rep. mode	NONE	–	V1 15

Command description

This command determines the number of statistics cycles and the stepping mode for the measurement. A stop condition is not available

Note: *In the case of READ commands ([illegible] to) the <Repetition> parameter has no effect, the measurement is always stopped after a single shot.*

CONFigure:RFANalyzer:POWer:RTIMe <Time> Duration of power measurement

<Time>	Parameter description	Def value	Def. unit	FW vers.
0 to 1	Duration of measurement. Accuracy: ± 5E-10 s	20E-3	s	V1.15

Command description

This command defines the time period during which the peak power is determined With the time 0, the power is immediately measured on the measurement start, i.e. the instantaneous value is measured.

Results – Subsystem RFANalyzer:POWer?

The subsystem *RFANalyzer:POWer* starts the analyzer power measurement and returns the results. The subsystem corresponds to the *Analyzer Power* panel in the *Analyzer/Generator* menu.

Scalar measurement results:

READ[:SCALar]:RFANalyzer:POWer?	Start single shot measurement and return results
FETCh[:SCALar]:RFANalyzer:POWer?	Read out measurement results (unsynchronized)
SAMPle[:SCALar]:RFANalyzer:POWer?	Read out measurement results (synchronized)

Returned value	**Description**	**Def. value**	**Default unit**	**FW vers.**
–120.0 dBm to 47.0 dBm	RMS power of the RF input signal	NAN	dBm	V1.15

Command description

These commands are always queries. They start a measurement and return the scalar measurement result.

Subsystem RFGenerator

The subsystem *RFGenerator* configures and controls the RF generator. It corresponds to the *Generator* tab in the popup menu *Connect. Control*. The generator generates two independent RF signals Tx and Aux Tx, referenced by the third-level keywords [:TX] and :AUXTx respectively.

DEFault:RFGenerator				Default Settings
<Enable>	Description of parameters	Def. value	Def. unit	FW vers.
ON | **OFF**	The parameters are set to default values Some or all parameters differ from the default values	ON	–	V3.40
Description of command				
If used as a setting command with the parameter *ON* this command sets all parameters of the `RFGenerator` subsystem to default values. The setting *OFF* results in an error message. If used as a query the command returns whether all parameters are set to default values *(ON)* or not *(OFF)*.				

DEFault:RFGenerator:TX				Default Settings
<Enable>	Description of parameters	Def. value	Def. unit	FW vers.
ON | **OFF**	The parameters are set to default values Some or all parameters differ from the default values	ON	–	V3.40
Description of command				
If used as a setting command with the parameter *ON* this command sets all parameters of the `RFGenerator` subsystem excluding the `RFGenerator:AUXTx` settings to default values. The setting *OFF* results in an error message. If used as a query the command returns whether all parameters are set to default values *(ON)* or not *(OFF)*.				

Subsystem RFGenerator (Generator Control)

The subsystem *RFGenerator* controls the RF generator. It corresponds to the *Generator Control* function in the *Generator* tab of the *Connection Control* menu.

INITiate:RFGenerator	Start RF generator, reserve resources	⇒ *RUN*
ABORt:RFGenerator	Switch off RF generator, release resources	⇒ *OFF*
Command description		FW vers.
These commands have no query form. They start or stop the RF generator, setting it to the status indicated in the top right column. The type of RF signal generated is selected via `CONFigure:RFGenerator:APPlication`.		V1.15

CONFigure:RFGenerator:APPLication *<Signal>*				Application
<Signal>	Parameter description	Def. value	Def. unit	FW vers.
TX | **AUXTx |** **TXAT**	Generate Tx signal only Generate Aux Tx signal only Generator both RF signals (Tx and Aux Tx)	OFF	–	V3.40
Command description				
This command qualifies which RF signal is generated when the RF generator is switched on (`INITiate:RFGenerator`).				

FETCh:RFGenerator:STATus? Generator status

Returned value	Parameter description	Def. value	Def. unit	FW vers.
OFF | **RUN |** **ERR**	Generator switched off (`ABORt` or `*RST`) Running (`INITiate`) Switched off (could not be started)	OFF	–	V1.15

Command description

This command is always a query. It returns the current generator status.

Subsystem RFGenerator... (Generator Settings)

The subsystem *RFGenerator...* determines the level and frequency of the RF generator. It corresponds to the input field *RF Level* and the *Frequency* softkey in the *Generator* panel (in *Connection Control*, *Generator* tab and in the *Analyzer/Generator* menu).

SOURce:RFGenerator[:TX]:LEVel *<Level>* RF Level

<Level>	Parameter description	Def. value	Def. unit	FW vers.
–137.0 to –27.0 dBm	RF1 level in the used timeslot	–27.0	dBm	V1.15
–137.0 to –10.0 dBm	RF2 level in the used timeslot	–27.0	dBm	
–90.0 to +13.0 dBm	RF 3 OUT level in the used timeslot	–27.0	dBm	

Command description

This command defines the RF generator level. The permissible value range depends on the used RF output of the CMU and the external attenuation. Moreover, in the SSB mode (see command [illegible]), the level ranges for all three connectors are shifted by –2 dB, and the default value for RF1 OUT is –29.0 dBm. The level ranges are also modified if the Tx and Aux Tx signals are both active and superimposed at the same connector.

SOURce:RFGenerator[:TX]:FREQuency *<Frequency>* Frequency

<Frequency>	Parameter description	Def. value	Def. unit	FW vers.
100 kHz to 2.7 GHz	Output frequency (resolution 0.1 Hz)	1200 MHz	Hz	V1.15

Command description

This command defines the output frequency of the RF generator. The usable frequency range exceeds the specified range, see data sheet.

Subsystem RFGenerator:MODulation (Frequency Modulation)

The subsystem *RFGenerator:MODulation* determines the frequency modulation of the internal RF generator. It corresponds to the *Modulation* settings in the *Generator* tab of the *Connection Control* menu.

SOURce:RFGenerator:MODulation <*State*> Modulation

<State>	Parameter description	Def. value	Def. unit	FW vers.
OFF |	No modulation, continuous wave	OFF	–	V1.15,
SSB |	RF output signal shifted by a constant offset frequency			V2.15
AM	RF output signal amplitude-modulated			(AM)

Command description

This command determines the modulation of the RF output signal. In the *SSB* mode, the frequency of the RF output signal is shifted by the frequency defined via `CONF:RFG:MOD:SSB:FREQ`. In the *AM* mode, the signal is modulated with the frequency defined via `CONF:RFG:MOD:SSB:FREQ` and with the modulation index defined via `CONF:RFG:MOD[:AM]:IND`; see below.

SOURce:RFGenerator:MODulation:SSB:FREQuency <*Deviation*> AF Frequency

<Deviation>	Parameter description	Def. value	Def. unit	FW vers.
–300 kHz to +300 kHz	SSB frequency offset (resolution 1 kHz)	1000	Hz	V1.15,
|	AM modulation frequency	1000	Hz	V2.15
0 kHz to +300 kHz				(AM)

Command description

This command generates an AF frequency which defines either a frequency offset (if `SOUR:RFG:MOD` is set to `SSB`) or an AM modulation frequency (if `SOUR:RFG:MOD` is set to `AM`). A frequency offset can be either positive or negative; modulation frequencies must be positive.

SOURce:RFGenerator:MODulation[:AM]:INDex <*Mod_Index*> Modulation Index

<Mod_Index>	Parameter description	Def. value	Def. unit	FW vers.
0 % to 100 %	Modulation index	100	%	V1.15, V2.15 (AM)

Command description

This command defines the modulation index for AM modulation, i.e. the amplitude ration between the modulating AM signal to the RF carrier signal in percent.

Subsystem RFGenerator:FHOPping (Frequency Hopping)

The subsystem *RFGenerator:FHOPping* determines the frequency hopping of the internal RF generator. It corresponds to the *Frequency Hopping* settings in the *Generator* tab of the *Connection Control* menu.

SOURce:RFGenerator:FHOPping:STATe <State> Frequency Hopping

<State>	Parameter description	Def. value	Def. unit	FW vers.
OFF | **ON**	No frequency hopping Frequency hopping active (between the frequencies set via `SOUR:RFG:FREQ` and `SOUR:RFG:FHOP:FREQ`)	OFF	–	V1.15

Command description

This command switches the hopping output frequency of the RF generator on or off.

SOURce:RFGenerator:FHOPping:FREQuency <*Frequency*> Hopping Frequency

<Frequency>	Parameter description	Def. value	Def. unit	FW vers.
absolute: **100.0 kHz to 2.7 GHz**	Hopping frequency (in multiples of 0.1 Hz)	0 MHz (Hopping off)	Hz	V1.15
relative: **depending on normal frequency**	within the rated generator frequency range			

Command description

This command defines the hopping output frequency of the RF generator. This alternative frequency and the frequency set via [illegible] are used for hopping. The command [illegible] qualifies whether the value is meant to be relative to `SOUR.RFG:FREQ` or absolute.

SOURce:RFGenerator:FHOPping:FREQuency:MODE <Mode> Hopping Mode

<Mode>	Parameter description	Def. value	Def. unit	FW vers.
	Hopping frequency	RELative	–	V1.15
ABSolute |	Absolute with respect to the RF generator frequency			
RELative	Relative to the RF generator frequency			

Command description

This command qualifies whether the frequency set using [illegible] is meant to be relative to `SOUR:RFG:FREQ` or absolute.

Subsystem RFGenerator:PULSe (Ramping)

The subsystem *RFGenerator:PULSe* determines the ramping mode of the internal RF generator. It corresponds to the *Ramping* setting in the *Generator* tab of the *Connection Control* menu.

SOURce:RFGenerator:PULSe:STATe <State> Ramping

<State>	Parameter description	Def. value	Def. unit	FW vers.
OFF |	CW signal	OFF	–	V1.15
ON	Pulsed signal with 577 µs burst length			

Command description

This command determines whether the RF generator generates a CW signal or a GSM-like burst signal.

Subsystem RFGenerator:BANDwidth (Bandwidth)

The subsystem *RFGenerator:BANDwidth* sets the bandwidth of the modulation filter. It corresponds to the *Modulation Filter* setting in the *Generator* tab of the *Connection Control* menu.

SOURce:RFGenerator:BANDwidth <*Bandwidth*>
SOURce:RFGenerator:BWIDth <*Bandwidth*> Bandwidth

<Bandwidth>	Parameter description	Def. value	Default unit	FW vers.
OFF |	Off (broadband)	F300	–	V1.15
F30Khz |	30 kHz bandwidth			
F300khz	300 kHz bandwidth			

Command description

This command defines the bandwidth of the modulation filter.

Subsystem RFGenerator:AUXTx... (Aux TX Signal)

The subsystem *RFGenerator:AUXTx* configures the auxiliary generator signal Aux Tx (only with option CMU-B95, *Additional RF Generator)*. It corresponds to the *Generator Aux Tx* section in the *Generator* tab of the *Connection Control* menu.

Aux Tx is an additional TX signal generated by the CMU that can be applied to the one of the RF connectors RF1 or RF2. It is possible to superimpose both RF signals at the same output connector or use different connectors (commands `OUTPut[:TX][:STATe]` and `OUTPut:AUXTx[:STATe]`). Moreover, it is possible to assign independent external attenuation factors to both signals `([SENSe:] CORRection:LOSS:OUTPut<nr>[:TX][:MAGNitude], SOURce:CORRection:LOSS:OUTPut<nr>[:TX][:MAGNitude], [SENSe:]CORRection:LOSS:OUTPut<nr>[:TX][:MAGNitude], SOURce:CORRection:LOSS:OUTPut<nr>[:TX][:MAGNitude])`.

Aux Tx is generated with the modulation settings of the primary TX signal `(...RFGenerator:MODulation...)` but with no frequency hopping or ramping.

DEFault:RFGenerator:AUXTx				Default Settings
<Enable>	Description of parameters	Def. value	Def. unit	FW vers.
ON | **OFF**	The parameters are set to default values Some or all parameters differ from the default values	ON	–	V3.40

Description of command

If used as a setting command with the parameter *ON* this command sets all parameters of the `RFGenerator:AUXTx` subsystem to default values. The setting *OFF* results in an error message.

If used as a query the command returns whether all parameters are set to default values *(ON)* or not *(OFF)*.

SOURce:RFGenerator:AUXTx:LEVel ***<Level>***				RF Level
<Level>	Parameter description	Def. value	Def. unit	FW vers.
–122 dBm to –72 dBm **–110 dBm to –60 dBm**	Aux Tx output level at RF1 Aux Tx output level at RF2	–72.0 –72.0	dBm dBm	V3.40

Command description

This command defines the Aux Tx signal level. The resolution is 1 dBm, all values entered are rounded to integer dBm steps. The value range depends on the used RF output of the CMU and the external attenuation. Moreover, in the SSB mode (see command [illegible]), the level ranges for all three connectors are shifted by –2 dB. The level ranges are also modified if the Tx and Aux Tx signals are both active and superimposed at the same connector.

SOURce:RFGenerator:AUXTx:FREQuency ***<Frequency>***				Frequency
<Frequency>	Parameter description	Def. value	Def. unit	FW vers.
350 MHz to 550 MHz | **700 MHz to 1100 MHz |** **1400 MHz to 2200 MHz**	Aux Tx frequency	350 MHz	Hz	V3.40

Command description

This command defines the frequency of the generated Aux Tx signal. The resolution is 200 kHz, all values entered are rounded to 100 kHz steps. If a value between the three distinct frequency bands is entered, the instrument generates an error message.

Subsystem INPut, OUTPut, CORRection:LOSS (⊕/Ext. Att.)

The subsystem for input and output contains the commands for configuration of the input and output connectors. The subsystem corresponds to the tab *RF* ⊕ in the popup menu *Connect. Control*.

INPut[:STATe] <*State*> RF Input

<*State*>	Parameter description	Def. value	Default unit	FW vers.
RF1	Connector RF1 used as input	RF2	–	V1.15
RF2	Connector RF2 used as input			
RF4	Connector RF4 IN used as input			

Command description

This command determines the connector to be used for incoming RF signals.

The bidirectional connectors RF 1 and RF 2 can be used both as input and output connectors in the same measurement (see `OUTPut[:STATe]`). Only one input and one output may be active at a time, which is why the currently active one is automatically deactivated on switchover.

OUTPut[:TX][:STATe] <*State*> RF Output

<*State*>	Parameter description	Def. value	Default unit	FW vers.
RF1	Connector RF1 used as output	RF2	–	V1.15
RF2	Connector RF2 used as output			
RF3	Connector RF3 OUT used as output			

Command description

This command determines the connector to be used for outgoing RF signals.

The bidirectional connectors RF 1 and RF 2 can be used both as input and output connectors in the same measurement. Only one input and one output may be active at a time, which is why the currently active one is automatically deactivated.

[SENSe:]CORRection:LOSS:INPut<nr>[:MAGNitude] <*Absorption*>
SOURce:CORRection:LOSS:INPut<nr>[:MAGNitude] <*Absorption*> Ext. Att. Input

<*Absorption*>	Parameter description	Def. value	Default unit	FW vers.
–50 dB to +50 dB	Value for external attenuation at Input <nr>, where <nr> = 1,2	0.0	dB	V1.15
–90 dB to +90 dB	Value for external attenuation at Input <nr>, where <nr> = 4	0.0	dB	

Command description

This commands assigns an external attenuation value to the inputs of the instrument.

[SENSe:]CORRection:LOSS:OUTPut<nr>[:TX][:MAGNitude] *<Absorption>*
SOURce:CORRection:LOSS:OUTPut<nr>[:TX][:MAGNitude] *<Absorption>* Ext. Att. Output

<Absorption>	Parameter description	Def. value	Default unit	FW vers.
–50 dB to +50 dB	Value for external attenuation at output <nr>, where <nr> = 1,2	0.0	dB	V1.15
–90 dB to +90 dB	Value for external attenuation at output <nr>, where <nr> = 3	0.0	dB	

Command description

This command assigns an external attenuation value to the outputs of the instrument. An external attenuation of x dB increases the Tx signal level (`SOURce:RFGenerator[:TX]:LEVel`) by x dB.

OUTPut:AUXTx[:STATe] *<State>* RF Output

<State>	Parameter description	Def. value	Default unit	FW vers.
RF1 **RF2**	Connector RF1 used as output Connector RF2 used as output	RF2	–	V3.40

Command description

This command determines the output connector to be used for the generated Aux Tx signal. The bidirectional connectors RF 1 and RF 2 can be used both as input and output connectors in the same measurement. Only one input and one output may be active simultaneously, so the previous one is automatically deactivated on switch-over.

[SENSe:]CORRection:LOSS:OUTPut<nr>:AUXTx[:MAGNitude] *<Absorption>*
SOURce:CORRection:LOSS:OUTPut<nr>:AUXTx[:MAGNitude] *<Absorption>* Ext. Att. Output

<Absorption>	Parameter description	Def. value	Default unit	FW vers.
–50 dB to +50 dB	Value for external attenuation at output <nr>, where <nr> = 1,2	0.0	dB	V3.40

Command description

This command assigns an external attenuation value to the outputs of the instrument. An external attenuation of x dB increases the Aux Tx signal level (`SOURce:RFGenerator:AUXTx:LEVel`) by x dB.

Subsystem DM:CLOCk (Synchronization)

The subsystem *DM:CLOCk* sets a network-specific system clock. The subsystem corresponds to the tab *Sync.* in the popup menu *Connect. Control*.

SOURce:DM:CLOCk:STATe *<Mode>* REF OUT 2

<Mode>	Parameter description	Def. value	Def. unit	FW vers.
ON | OFF	Switch system clock on/off	OFF	–	V1.15

Command description

This command switches the system clock at the output *REF OUT 2* on or off.

SOURce:DM:CLOCk:FREQuency <Frequency>				Clock Frequency
<Frequency>	Parameter description	Def. value	Def. unit	FW vers.
1.219 MHz to 40.000 MHz	Frequency of network-specific system clock	13	MHz	V1.15

Command description

This command defines the frequency at the output *REF OUT2*. In FW V2.15 ff. the frequency entered is rounded to the following discrete values:

40.000 MHz, 20.000 MHz, 13.333 MHz, 10.000 MHz, 8.000 MHz, 6.667 MHz, 5.714 MHz,
5.000 MHz, 4.444 MHz, 4.000 MHz, 3.636 MHz, 3.333 MHz, 3.077 MHz, 2.857 MHz,
2.667 MHz, 2.500 MHz, 2.353 MHz, 2.222 MHz, 2.105 MHz, 2.000 MHz, 1.905 MHz,
1.818 MHz, 1.739 MHz, 1.667 MHz, 1.600 MHz, 1.538 MHz, 1.481 MHz, 1.429 MHz,
1.379 MHz, 1.333 MHz, 1.290 MHz, 1.250 MHz

The formula of the sequence reads as follows:

$$f_n = f_1 \frac{1}{n} \text{ with } n = 1, 2, 3, \ldots 32 \text{ and } f_1 = 40 \text{ MHz for RF}$$

If the entered value f is between two allowed values f_n and f_{n+1}, it is rounded to:

$$f \rightarrow f_n \text{ if } f \geq f_1 \frac{1}{n+0.5} \text{ and } f \rightarrow f_{n+1} \text{ if } f < f_1 \frac{1}{n+0.5}.$$

I/Q-IF Interface

The subsystem *IQIF* configures the signal paths for I/Q and IF signals provided by option CMU-B17, *I/Q and IF Interfaces*. It corresponds to the *I/Q-IF* tab of the *Connection Control* menu.

Hint: *How to make sense out of parameter names*

In all path configurations except bypass, both the I/Q and IF output are connected (to either the RF Unit, the Digital Unit or one of the I/Q-IF inputs). The paths differ in the connection of the input branches: The qualifier IO denotes a connected input (with connected output), XO denotes a disconnected input (with connected output). Many parameters of the IQIF commands are composed of two IO/XO qualifiers, the first one standing for the IF signal, the second for the I/Q signal.

Example: *The parameter IOXO denotes a connected IF input and a disconnected IF output, while both output branches are connected.*

For more information see the menu description and the application examples in Chapter 4.

CONFigure:IQIF:RXTXcombined *<Scenario>* I/Q-IF

<Scenario>	Description of parameters	Def. value	Def. unit	FW vers.
BYP	RX/TX Bypass, `RXPath = BYP, TXPath = BYP`	BYP	–	V3.10
BYIQ	Bypass w. I/Q-OF OUT, `RXPath = TXPath =BYIQ`			
XOIO	I/Q IN/OUT, `RXPath = TXPath = XOIO`			
IOIO	IF IN_I/Q IN/OUT, `RXPath = TXPath = IOIO`			
IOXO	IF IN/OUT, `RXPath = TXPath = IOXO`			
FPAT	Fading Path, `RXPath = BYP, TXPath = XOIO`			
UDEF	User-defined scenario, can not be set but may be returned by the query `CONF:IQIF:RXTX?`			

Description of command

This command selects the I/Q-IF test scenario overwriting the current RX and TX path settings (see commands `CONFigure:IQIF:RXPath` and `CONFigure:IQIF:TXPath` below). Six different predefined test scenarios with fixed RX and TX path are provided. Additional scenarios may be defined by selecting any other combination of RX and RX paths.

Note: *`UDEF` is not provided as a setting parameter. If the RX/TX path combination defined via `CONFigure:IQIF:RXPath` and `CONFigure:IQIF:TXPath` doesn't correspond to any of the predefined scenarios, then a user-defined scenario is set implicitly, i.e. the query `CONF:IQIF:RXTX?` returns the value `UDEF`.*

CONFigure:IQIF:RXPath *<Path>* RX Path

<Path>	Description of parameters	Def. value	Def. unit	FW vers.
BYP	Bypass	BYP	–	V3.10
BYIQ	Bypass w. I/Q-IF OUT			
XOIO	I/Q IN/OUT			
IOIO	IF IN_I/Q IN/OUT			
IOXO	IF IN/OUT			

Description of command

This command selects the RX signal path, leaving the TX path (see command `CONFigure:IQIF:TXPath` below) unchanged but adapting the I/Q-IF test scenario to the new RX/TX path combination. If the combination corresponds to a predefined scenario, then `CONFigure:IQIF:RXTXcombined` is set to the predefined scenario; otherwise it is set to `UDEF`.

CONFigure:IQIF:TXPath *<Path>* TX Path

<Path>	Description of parameters	Def. value	Def. unit	FW vers.
BYP	Bypass	BYP	–	V3.10
BYIQ	Bypass w. I/Q-IF OUT			
XOIO	I/Q IN/OUT			
IOIO	IF IN_I/Q IN/OUT			
IOXO	IF IN/OUT			

Description of command

This command selects the TX signal path, leaving the RX path (see command `CONFigure:IQIF:RXPath` above) unchanged but adapting the I/Q-IF test scenario to the new RX/TX path combination: If the combination corresponds to a predefined scenario, then `CONFigure:IQIF:RXTXcombined` is set to the predefined scenario; otherwise it is set to `UDEF`.

IQIF:DEFault <Enable> Default Settings

<Enable>	Description of parameters	Def. value	Def. unit	FW vers.
ON | **OFF**	The parameters are set to their default values Some or all parameters differ from the default values	ON	–	V3.10

Description of command

If used as a setting command with the parameter *ON* this command sets all parameters of the subsystem to their default values (the setting *OFF* causes an error message).

If used as a query the command returns whether all parameters are set to their default values *(ON)* or not *(OFF)*.

Power Measurements (POWer)

The subsystem *POWer* measures the RF signal power versus time. The subsystem corresponds to the measurement menu *Power* and the associated popup menu *Power Configuration.*

Measurement Control – Subsystem POWer

The subsystem *POWer* controls the power measurement. The subsystem corresponds to the *Power* main softkey.

INITiate:POWer	Start new measurement	*⇒ RUN*
ABORt:POWer	Abort running measurement and switch off	*⇒ OFF*
STOP:POWer	Stop measurement after current evaluation period	*⇒ STOP*
CONTinue:POWer	Next measurement step (only *stepping mode*) *⇒ RUN*	
Command description		FW vers.
These commands have no query form. They start or stop the measurement, setting it to the status indicated in the top right column.		V1.15

CONFigure:POWer:EREPorting <*Mode*>		Event reporting of the measurement		
<Mode>	Parameter description	Def. value	Def. unit	FW vers.
SRQ |	Service request	OFF	–	V1.15
SOPC |	Single operation complete			
SRSQ |	SRQ and SOPC			
OFF	No reporting			
Command description				
This command defines the events generated when the measurement is terminated or stopped *(event reporting*, see chapter 5).				

FETCh:POWer:STATus?		Measurement status		
Returned value	Parameter description	Def. value	Def. unit	FW vers.
OFF |	Measurement in the OFF state (*RST or ABORt)	OFF	–	V1.15
RUN |	Running (after INITiate, CONTinue or READ)			
STOP |	Stopped (STOP)			
ERR |	OFF (could not be started)			
STEP |	Stepping mode (<stepmode>=STEP)			
RDY,	Stopped according to repetition mode and stop condition			
	Counter for measurement cycles			
0 to 10000 |	Counter not used	NONE	–	
NONE				
	Counter for current evaluation period within a cycle			
1 to 1000 |	Statistic count set to off	NONE	–	
NONE				
Command description				
This command is always a query. It returns the status of the measurement (see chapters 3 and 5).				

Test Configuration

The commands in the following subsystems configure the *Power* measurement. They correspond to the *Power Configuration* popup menu.

Subsystem POWer:CONTrol (Control)

The subsystem *POWer:CONTrol* defines the scope of the *Power* measurement. The subsystem corresponds to the *Control* tab of the *Power Configuration* menu.

CONFigure:POWer:CONTrol *<Mode>* Scope of measurement

<Mode>	Desciption of parameters	Def. value	Def. unit	
SCALar | **ARRay**	Scalar values only (incl. limit matching) Scalar measured values and arrays	ARRay	–	
<Statistics>	Description of parameters	Def. value	Def. unit	FW vers.
1 to 1000 | **NONE**	Number of sweeps per statistics cycle Statistics off (equivalent to 1)	1	–	≥1.15

Description of command

This command specifies the type of measured values.

CONFigure:POWer:CONTrol:REPetition *<Repetition>* ,*<StopCondition>*,*<Stepmode>* Measurement cycles

<Repetition>	Parameter description	Def. value	Def. unit	FW vers.
CONTinuous | **SINGleshot |** **1 to 10000**	Continuous measurement (until `STOP` or `ABORT`) Single shot measurement (until `Status = RDY`) Multiple measurement (*counting*, until `Status = STEP | RDY`)	SING	–	
<StopCondition>	Parameter description	Def. value	Def. unit	
NONE	Continue measurement even in case of error	NONE	–	
<Stepmode>	Description of parameters	Def. value	Def. unit	FW vers.
STEP | **NONE**	Interrupt measurement after each statistics cycle Continue measurement according to its rep. mode	NONE	–	V1.15

Command description

This command defines the repetition mode and the stepping mode for the measurement. A stop condition is not available.

Note: *In the case of READ commands (`READ:` to) the <Repetition> parameter has no effect; the measurement is always stopped after a single shot.*

Subsystem POWer:FREQuency (Frequency/RBW)

The subsystem *POWer:FREQuency* sets the frequency and resolution bandwidth of the *Power* measurement. The subsystem corresponds to the *Analyzer Settings* softkey in the graphical measurement menu *Power*.

[SENSe:]POWer:FREQuency:CENTer *<Frequency>*				Frequency
<Frequency>	Parameter description	Def. value	Default unit	FW vers.
10 kHz to 2.7 GHz	Frequency (0.1 Hz resolution)	1000 MHz	Hz	V1.15
Command description				
This command defines the input frequency of the analyzer.				

[SENSe:]POWer:FREQuency:BANDwidth[:RESolution] *<Bandwidth>* **[SENSe:]POWer:FREQuency:BWIDth[:RESolution] *<Bandwidth>***				RBW
<Bandwidth>	Parameter description	Def value	Default unit	FW vers.
10 Hz to 1 MHz	Bandwidths of power measurement (the values are rounded in the steps 1 | 2 | 3 | 5)	300 kHz	–	V1.15
Command description				
This command defines the bandwidth of the power measurement.				

Subsystem POWer:LEVel (Level)

The subsystem *POWer:LEVel* sets the level range displayed. The subsystem corresponds to the *Level Scale* hotkey in the graphical measurement menu *Power.*

[SENSe:]POWer:LEVel:RANGe *<Range>*				Range
<Range>	Parameter description	Def. value	Default unit	FW vers.
10.0 dB to 100.0 dB	Level range of the power measurement	100.0 dB	–	V1.15
Command description				
This command defines the level range of the *Power* measurement.				

Subsystem POWer:TIME

The subsystem *POWer:TIME* configures the time axis. The subsystem corresponds to the *Time Scale* hotkey in the graphical measurement menu *Power.*

[SENSe:]POWer:TIME:DELay <*Delay*> Delay

<Delay>	Parameter description	Def. value	Default unit	FW vers.
See below	Delay time between trigger time and start of the measurement	–10.0 µs	s	V1.15

Command description

This command defines the time when the measurement is started relative to the trigger time.

The permissible range of delays depends on the span and bandwidth, e.g.:

- 152.9 µs to 142.9 µs (bandwidth 1 MHz, span 10 µs)

- 15.7919207 s to 5.7919207 s (bandwidth 10 Hz, span 10 s)

[SENSe:]POWer:TIME:SPAN <*Span*> Span

<Span>	Parameter description	Def. value	Default unit	FW vers.
10 µs to 10 s	Span of the power measurement	100 µs	s	V1.15

Command description

This command defines the span (i.e. the total evaluation time) of the *Power* measurement. The permissible spans depend on the selected bandwidth.

CONFigure:POWer:CONTrol:TIMeout <*Timeout*> Timeout for triggered measurements

<Timeout>	Parameter description	Def. value	Default unit	FW vers.
1 s to 60 s	Timeout period after which the measurement is aborted	10 s	s	V1.15

Command description

This command defines a timeout period after which the measurement is aborted (e.g. if no trigger event could be detected).

Subsystem SUBarrays:POWer

The subsystem *SUBarrays:POWer* defines the measurement range and the type of output values.

CONFigure:SUBarrays:POWer Definition of Subarrays
<Mode>,<Start>,<Samples>{,<Start>,<Samples>}

<Mode>	Description of parameters	Def. value	Def. unit	
ALL | **ARIThmetical |** **MINimum |** **MAXimum |** **IVAL,**	Return all measurement values Return arithm. mean value in every subrange Return minimum value in every subrange Return maximum value in every subrange Return single interpolated value at <Start>	ALL	–	
<Start>	Description of parameters	Def. value	Def. unit	
–15 s to 15 s,	Start time in current range	Min	s	
<Samples>	Description of parameters	Def. value	Def. unit	FW vers.
1 to 500	Number of samples in current subrange	Max	–	3.0

Description of command

This command configures the `READ:SUBarrays:POWer...`, `FETCh:SUBarrays:POWer...`, and `SAMPle:SUBarrays:POWer` commands. It restricts the measurement to up to 32 subranges where either all measurement results (the number of which is given by the second numerical parameter) or a single statistical value is returned. The subranges are defined by the start time and the number of test points to be measured.

For <Mode> = IVAL, the <Samples> parameter is ignored and the CMU returns a single measurement value corresponding to the abscissa value <Start>. If <Start> is located between two test points with valid results then the result is calculated from the results at these two adjacent test points by linear interpolation.

The subranges may overlap but must be within the total range of the `POWer` measurement defined via `[SENSe:]POWer:TIME:DELay` and `[SENSe:]POWer:TIME:SPAN`. Test points outside this range are not measured (result *NAN)* and do not enter into the `ARIThmetical`, `MINimum` and `MAXimum` values.

By default, only one range corresponding to the total measurement range is used and all measurement values are returned.

Results – Subsystem POWer...?

The subsystem *POWer...?* starts the power measurement and returns the results. The subsystem corresponds to the graphical measurement menu *Power.*

READ:ARRay:POWer[:CURRent]?
READ:ARRay:POWer:AVERage?
READ:ARRay:POWer:MAXimum?
READ:ARRay:POWer:MINimum?

Power Results

Start single shot meas. and return results ⇒ *RUN*

FETCh:ARRay:POWer[:CURRent]?
FETCh:ARRay:POWer:AVERage?
FETCh:ARRay:POWer:MAXimum?
FETCh:ARRay:POWer:MINimum?

Read meas. results (unsynchronized) ⇒ *RUN*

SAMPle:ARRay:POWer[:CURRent]?
SAMPle:ARRay:POWer:AVERage?
SAMPle:ARRay:POWer:MAXimum?
SAMPle:ARRay:POWer:MINimum?

Read results (synchronized) ⇒ *RUN*

Returned value	Parameter description	Def. value	Default unit	FW vers.
–128.0 dBm to + 48.0 dBm,	1st value for power	NAN	dBm	V 1.15
...,				
–128.0 dBm to + 48.0 dBm	500th value for power	NAN	dBm	

Command description

These commands are always queries. They return the power values versus time at 1000 equidistant test points. The measurement range is defined via `[SENSe:]POWer:TIME:DELay` and `[SENSe:]POWer:TIME:SPAN`.

Note: The number of test points may be reduced at very narrow measurement ranges.

READ:SUBarrays:POWer[:CURRent]? Subarray Results
READ:SUBarrays:POWer:AVERage?
READ:SUBarrays:POWer:MAXimum?
READ:SUBarrays:POWer:MINimum? Start single shot meas. and return results ⇒ *RUN*

FETCh:SUBarrays:POWer[:CURRent]?
FETCh:SUBarrays:POWer:AVERage?
FETCh:SUBarrays:POWer:MAXimum?
FETCh:SUBarrays:POWer:MINimum? Read meas. results (unsynchronized) ⇒ *RUN*

SAMPle:SUBarrays:POWer[:CURRent]?
SAMPle:SUBarrays:POWer:AVERage?
SAMPle:SUBarrays:POWer:MAXimum?
SAMPle:SUBarrays:POWer:MINimum? Read results (synchronized) ⇒ *RUN*

Ret. values by subrange	Description of parameters	Def. value	Def unit	FW vers.
–128.0 dBm to + 48.0 dBm	Power[1], 1st value for power	NAN	dBm	V3.0
...	.	.	...	
–128.0 dBm to + 48.0 dBm	Power[x], xth value for power	NAN	dBm	

Description of command

These commands are always queries. They return the power versus time in the subranges defined by means of the `CONFigure:SUBarrays:POWer` command. In the default setting of the configuration command the `READ:SUBarrays...`, `FETCh:SUBarrays...`, `and SAMPle:SUBarrays...` command group is equivalent to the `READ:ARRay...`, `FETCh:ARRay...`, `and SAMPle:ARRay...` command group described above.

The `CONFigure:SUBarrays:POWer` command defines a maximum of 32 subranges. If one of the statistical modes `(ARIThmetical, MINimum, MAXimum)` or `IVAL` is set, only one value is returned by subrange.

Spectrum Measurements (SPECtrum)

The subsystem *SPECtrum* measures the RF frequency spectrum. The subsystem corresponds to the measurement menu *Spectrum* and the associated popup menu *Spectrum Configuration.*

Measurement Control – Subsystem SPECtrum

The subsystem *SPECtrum* controls the spectrum measurement. It corresponds to the *Spectrum.* softkey in the measurement menu *Spectrum.*

INITiate:SPECtrum	Start new measurement	⇒ *RUN*
ABORt:SPECtrum	Abort running measurement and switch off	⇒ *OFF*
STOP:SPECtrum	Stop measurement after current evaluation period	⇒ *STOP*
CONTinue:SPECtrum	Next measurement step (only *stepping mode*)	⇒ *RUN*
Command description		FW vers.
These commands have no query form. They start or stop the measurement, setting it to the status indicated in the top right column.		V1.15

CONFigure:SPECtrum:EREPorting <*Mode*>				Event Reporting
<Mode>	Parameter description	Def. value	Def. unit	FW vers.
SRQ |	Service request	OFF	–	V1.15
SOPC |	Single operation complete			
SRSQ |	SRQ and SOPC			
OFF	No reporting			
Command description				
This command defines the events generated when the measurement is terminated or stopped *(event reporting,* see chapter 5).				

FETCh:SPECtrum:STATus?				Measurement status
Returned value	Parameter description	Def. value	Def. unit	FW vers.
OFF |	Measurement in the *OFF* state (`*RST` or `ABORt`)	OFF	–	V1.15
RUN |	Running (after `INITiate, CONTinue` or `READ`)			
STOP |	Stopped (`STOP`)			
ERR |	*OFF* (could not be started)			
STEP |	Stepping mode *(<stepmode>=STEP)*			
RDY,	Stopped according to repetition mode and stop condition			
	Counter for measurement cycles			
0 to 10000 | **NONE**	Counter not used	NONE	–	
	Counter for current evaluation period within a cycle			
1 to 1000 | **NONE**	Statistic count set to off	NONE	–	
Command description				
This command is always a query. It returns the status of the measurement (see chapters 3 and 5).				

[SENSe:]SPECtrum:DETector *<Mode>*				Detect Mode
<Mode>	Desciption of parameters	Def. value	Def. unit	FW vers.
PEAK | **RMS**	Meas. curve interpolated from maximum values Meas. curve interpolated from RMS averaged values	PEAK	–	V3.05
Description of command				
This command defines how the measurement curve is calculated from the entire set of measurement points.				

Test Configuration

The commands in the following subsystems configure the *Spectrum* measurement. They correspond to the *Spectrum Configuration* popup menu.

Subsystem SPECtrum:CONTrol

The subsystem *SPECtrum:CONTrol* defines the scope of the spectrum measurement. It corresponds to the tab *Control* in the popup menu *Spectrum Configuration*.

CONFigure:SPECtrum:CONTrol *<Mode>*, *<Statistics>*				Scope of measurement
<Mode>	Desciption of parameters	Def. value	Def. unit	
SCALar | **ARRay**	Scalar values only (incl. limit matching) Scalar measured values and arrays	ARRay	–	
<Statistics>	Description of parameters	Def. value	Def. unit	FW vers.
1 to 1000 | **NONE**	Number of sweeps per statistics cycle Statistics off (equivalent to 1)	1	–	≥1.15
Description of command				
This command specifies the type of measured values and defines the number of sweeps forming a statistics cycle.				

CONFigure:SPECtrum:CONTrol:REPetition *<Repetition>* ,*<StopCondition>*,*<Stepmode>*

Measurement cycles

<Repetition>	Parameter description	Def. value	Def. unit	
CONTinuous | **SINGleshot |** **1 to 10000**	Continuous measurement (until `STOP` or `ABORT`) Single shot measurement (until `Status = RDY`) Multiple measurement (*counting*, until `Status = STEP | RDY`)	SING	–	
<StopCondition>	Parameter description	Def. value	Def. unit	
NONE	Continue measurement in case of error	NONE	–	
<Stepmode>	Description of parameters	Def. value	Def. unit	FW vers.
STEP | **NONE**	Interrupt measurement after each statistics cycle Continue measurement according to its rep. mode	NONE	–	V1.15

Command description

This command defines the repetition mode and the stepping mode for the measurement. A stop condition is not available.

Note: In the case of READ commands (`READ:` to) the <Repetition> parameter has no effect; the measurement is always stopped after a single shot.

Subsystem SPECtrum:FREQuency (Frequency/RBW)

The subsystem *SPECtrum:FREQuency* defines the display range of the frequency axis and the resolution bandwidth. The subsystem corresponds to the *Analyzer Settings* softkey in the graphical measurement menu *Spectrum.*

[SENSe:]SPECtrum:FREQuency:CENTer *<Frequency>*
[SENSe:]SPECtrum:FREQuency:SPAN *<Frequency>*
[SENSe:]SPECtrum:FREQuency:STARt *<Frequency>*
[SENSe:]SPECtrum:FREQuency:STOP *<Frequency>*

Center / Span / Start

<Frequency>	Parameter description	Def. value	Default unit	FW vers.
10.0 MHz to 2.7 GHz	Center frequency	1105	MHz	V1.15
0.00001 MHz to 2.690 GHz	Frequency span	2190	MHz	
10 MHz to 2.7 GHz	Start frequency	10	MHz	
10.00001 MHz to 2.7 GHz	Stop frequency	2200	MHz	

Command description

This command sets the center frequency and span or the start and stop frequency of the spectrum analyzer. Start and stop frequency are used for calculation of the other two frequencies.

[SENSe:]SPECtrum:FREQuency:BANDwidth[:RESolution] *<Bandwidth>*
[SENSe:]SPECtrum:FREQuency:BWIDth[:RESolution] *<Bandwidth>*

RBW

<Bandwidth>	Parameter description	Def. value	Default unit	FW vers.
10 Hz to 1 MHz | **AUTO**	Bandwidths of measurement (the values are rounded in the steps 1 | 2 | 3 | 5)	AUTO	–	V1.15

Command description

This command defines the bandwidth of the spectrum measurement. The range of the bandwidth is shifted and increased along with the span of the measurement.

Subsystem SPECtrum:LEVel (Level)

The subsystem *POWer:LEVel* sets the level range of the *Spectrum* measurement. The subsystem corresponds to the *Level Scale* hotkey in the graphical measurement menu *Spectrum*.

[SENSe:]SPECtrum:LEVel:RANGe *<Range>*				Range
<Range>	Parameter description	Def. value	Default unit	FW vers.
10.0 dB to 100.0 dB	Level range for the spectrum measurement.	100.0 dB	–	V1.15
Command description				
This command defines the level range for the spectrum measurement.				

Subsystem SUBarrays:SPECtrum

The subsystem *SUBarrays:SPECtrum* defines the measurement range and the type of output values.

CONFigure:SUBarrays:SPECtrum **<Mode>,<Start>,<Samples>{,<Start>,<Samples>}**				Definition of Subarrays
<Mode>	Description of parameters	Def. value	Def. unit	
ALL | **ARIThmetical |** **MINimum |** **MAXimum |** **IVAL,**	Return all measurement values Return arithm. mean value in every subrange Return minimum value in every subrange Return maximum value in every subrange Return single interpolated value at <Start>	ALL	–	
<Start>	Description of parameters	Def. value	Def. unit	
10 MHz to 2.69999999 GHz,	Start frequency in current range	Min	Hz	
<Samples>	Description of parameters	Def. value	Def. unit	FW vers.
1 to 560	Number of samples in current subrange	Max	–	3.0
Description of command				

This command configures the `READ:SUBarrays:SPECtrum...`, `FETCh:SUBarrays:SPECtrum...`, and `SAMPle:SUBarrays:SPECtrum` commands. It restricts the measurement to up to 32 subranges where either all measurement results (the number of which is given by the second numerical parameter) or a single statistical value is returned. The subranges are defined by the start frequency and the number of test points to be measured.

For <Mode> = IVAL, the <Samples> parameter is ignored and the CMU returns a single measurement value corresponding to the abscissa value <Start>. If <Start> is located between two test points with valid results then the result is calculated from the results at these two adjacent test points by linear interpolation.

The subranges may overlap but must be within the total range of the `SPECtrum` measurement defined by the commands `[SENSe:]SPECtrum:FREQuency:CENTer` and `[SENSe:]SPECtrum: FREQuency:SPAN` or by `[SENSe:]SPECtrum:FREQuency:STARt` and `[SENSe:]SPECtrum: FREQuency:STOP`. Test points outside this range are not measured (result *NAN)* and do not enter into the `ARIThmetical`, `MINimum` and `MAXimum` values.

By default, only one range corresponding to the total measurement range is used and all measurement values are returned.

Results – Subsystem SPECtrum

The subsystem *SPECtrum* starts the *Spectrum* measurement and returns the results. The subsystem corresponds to the various output elements in the graphical measurement menu *Spectrum*.

Spectrum Results

READ:ARRay:SPECtrum[:CURRent]?
READ:ARRay:SPECtrum:AVERage?
READ:ARRay:SPECtrum:MAXimum?
READ:ARRay:SPECtrum:MINimum? Start single shot meas. and return results ⇒ *RUN*

FETCh:ARRay:SPECtrum[:CURRent]?
FETCh:ARRay:SPECtrum:AVERage?
FETCh:ARRay:SPECtrum:MAXimum?
FETCh:ARRay:SPECtrum:MINimum? Read meas. results (unsynchronized) ⇒ *RUN*

SAMPle:ARRay:SPECtrum[:CURRent]?
SAMPle:ARRay:SPECtrum:AVERage?
SAMPle:ARRay:SPECtrum:MAXimum?
SAMPle:ARRay:SPECtrum:MINimum? Read results (synchronized) ⇒ *RUN*

Returned value	Parameter description	Def. value	Default unit	FW vers.
–128.0 dBm to + 48.0 dBm	1st power value	NAN	dBm	V1.15
...				
–128.0 dBm to + 48.0 dBm	560th power value	NAN	dBm	

Command description

These commands are always queries. They return the results of the spectrum measurement at 560 equidistant test points. The measurement range is defined by the commands `[SENSe:]SPECtrum:FREQuency:CENTer` and `[SENSe:]SPECtrum:FREQuency: SPAN` or by `[SENSe:]SPECtrum:FREQuency:STARt` and `[SENSe:]SPECtrum: FREQuency:STOP`.

Note: The number of test points may be reduced at very narrow measurement ranges.

READ:SUBarrays:SPECtrum[:CURRent]?
READ:SUBarrays:SPECtrum:AVERage?
READ:SUBarrays:SPECtrum:MAXimum?
READ:SUBarrays:SPECtrum:MINimum?

Subarray Results

Start single shot meas. and return results ⇒ *RUN*

FETCh:SUBarrays:SPECtrum[:CURRent]?
FETCh:SUBarrays:SPECtrum:AVERage?
FETCh:SUBarrays:SPECtrum:MAXimum?
FETCh:SUBarrays:SPECtrum:MINimum?

Read meas. results (unsynchronized) ⇒ *RUN*

SAMPle:SUBarrays:SPECtrum[:CURRent]?
SAMPle:SUBarrays:SPECtrum:AVERage?
SAMPle:SUBarrays:SPECtrum:MAXimum?
SAMPle:SUBarrays:SPECtrum:MINimum?

Read results (synchronized) ⇒ *RUN*

Ret. values by subrange	Description of parameters	Def. value	Def. unit	FW vers.
–128.0 dBm to + 48.0 dBm	Power[1], 1st value for power	NAN	dBm	3.0
...	...	...	...	
–128.0 dBm to + 48.0 dBm	Power[x], xth value for power	NAN	dBm	

Description of command

These commands are always queries. They return the power versus frequency in the subranges defined by means of the [illegible] command. In the default setting of the configuration command the `READ:SUBarrays...`, `FETCh:SUBarrays...`, and `SAMPle:SUBarrays...` command group is equivalent to the `READ:ARRay...`, `FETCh:ARRay...`, and `SAMPle:ARRay...` command group described above.

The [illegible] command defines a maximum of 32 subranges. If one of the statistical modes (`ARIThmetical`, `MINimum`, `MAXimum`) or `IVAL` is set, only one value is returned by subrange.

The calculation of `CURRent`, `AVERage`, `MINimum`, and `MAXimum` results is explained in Chapter 3 (see *Display Mode)*.

WPOWer

The subsystem *WPOWer* measures the power of the signal transmitted by the mobile phone over a wide frequency range. It corresponds to the softkey *Pow. Meter Wideband* in the *RF* connector tab of the *Connect. Control* menu.

INITiate:WPOWer	Start new measure ment	⇒ *RUN*
ABORt:WPOWer	Abort measurement and switch off	⇒ *OFF*
STOP:WPOWer	Stop measurement	⇒ *STOP*
CONTinue:WPOWer	Next measurement step (only *counting mode*)	⇒ *RUN*

Description of command	FW vers.
These commands have no query form. They start or stop the measurement, setting it to the status given in the top right column.	V3.10

CONFigure:WPOWer:EREPorting <*Mode*> Event Reporting

<Mode>	Description of parameters	Def. value	Def. unit	FW vers.
SRQ |	Service request	OFF	–	V3.10
SOPC |	Single operation complete			
SRSQ |	SRQ and SOPC			
OFF	No reporting			

Description of command

This command defines the events generated when the measurement is terminated or stopped *(event reporting,* see Chapter 5).

FETCh:WPOWer:STATus? Measurement

Return	Description of parameters	Def. value	Def. unit	FW vers.
OFF |	Measurement in the *OFF* state (`*RST` or `ABORt`)	OFF	–	V3.10
RUN |	Running (after `INITiate`, `CONTinue` or `READ`)			
STOP |	Stopped (`STOP`)			
ERR |	*OFF* (could not be started)			
STEP |	Stepping mode *(<stepmode>=STEP)*			
RDY,	Stopped according to repetition mode and stop condition			
	Counter for current statistics cycle			
1 ... 10000 |	No counting mode set			
NONE		NONE	–	

Description of command

This command is always a query. It returns the status of the measurement (see chapters 3 and 5 of CMU operating manual).

CONFigure:WPOWer:CONTrol:REPetition ***<Repetition>,<StopCond>,<Stepmode>***				Test cycles
<Repetition>	Description of parameters	Def. value	Def. unit	
CONTinuous | **SINGleshot |** **1 ... 10000**	Continuous measurement (until `STOP` or `ABORT`) Single shot measurement (until `Status = RDY`) Multiple measurement (*counting*, until `Status = STEP | RDY`)	SING	–	
<StopCond>	Description of parameters	Def. value	Def. unit	
SONerror | **NONE**	Start measurement in case of error *(stop on error)* Continue measurement even in case of error	NONE	–	
<Stepmode>	Description of parameters	Def. value	Def. unit	FW vers.
STEP | **NONE**	Interrupt measurement after each statistics cycle Continue measurement according to its rep. mode	NONE	–	V3.10
Description of command				
This command determines the number of statistics cycles, the stop condition and the stepping mode for the measurement. **Note:** *In the case of READ commands ([illegible]), the <Repetition> parameter has no effect; the measurement is always stopped after a single shot.*				

Measured Values – Subsystem WPOWer?

The subsystem *WPOWer?* retrieves the results of the wideband power measurement.

READ[:SCALar]:WPOWer? **FETCh[:SCALar]:WPOWer?** **SAMPle[:SCALar]:WPOWer?**		Start single shot measurement and return results Read out measurement results (unsynchronized) Read out measurement results (synchronized)		
Return	Description of parameters	Def. value	Def. unit	FW vers.
0 dBm to +55 dBm **–10 dBm to +35 dBm** **–35 dBm to +2 dBm**	Maximum RF power at RF1 Maximum RF power at RF2 Maximum RF power at RF 4 IN	NAN	dBm	V3.10
Description of command				
These commands are always queries. They start the measurement of the maximum RF power (peak power, not averaged) and return the result.				

NPOWer (Function Group RF)

The subsystem *NPOWer* measures the power of an RF signal using a narrow-band filter with variable bandwidth. Gaussian filters with bandwidths between 10 Hz and 1 MHz are available. In addition, the measurement can be performed with the root-raised cosine filter specified in standard TIA/EIA-136.xxx or with an 1.4 MHz bandpass filter specified for CDMA measurements.

The *NPOWer* measurement is performed at the frequency set via `[SENSe:]RFANalyzer:FREQuency`. The filter bandwidth *(RBW)* is set via `[SENSe:]NPOWer:BWIDth[:RESolution]`; it does not depend on the RBW defined for the *POWer* and *SPECtrum* measurement.

The CMU measures the average, maximum and minimum power of the RF signal in a basic evaluation period comprising a fixed number of samples (4096). In addition to these *Current* values the minimum and maximum power in the entire measurement and the average of the average current values, referenced to a statistics cycle, is calculated (see section *Measured Values – Subsystem NPOWer?* on p. 6.62 ff.). The measurement time depends on the filter bandwidth but never exceeds the order of magnitude of 100 ms for a single evaluation period. The frequency of the RF signal is also measured, provided that is close enough to the measurement frequency set via `[SENSe:]POWer:FREQuency:CENTer`. The characteristics of the *NPOWer* measurement makes it particularly suitable for the analysis of CW signals where no measurement curves are needed. Compared to the *Analyzer Power* measurement (subsystem `RFANalyzer`), it provides a wider range of filters, additional statistical evaluations and an additional frequency counter.

Note: *The configuration of the RF input path (`[SENSe:]LEVel:MAXimum`, `[SENSe:]LEVel:MODE`) and the trigger settings (`TRIGger[:SEQuence]:SOURce`, `TRIGger[:SEQuence]:THReshold`) can have an effect on the `NPOWer` measurement.*

INITiate:NPOWer	Start new measurement	⇒ *RUN*
ABORt:NPOWer	Abort measurement and switch off	⇒ *OFF*
STOP:NPOWer	Stop measurement	⇒ *STOP*
CONTinue:NPOWer	Next measurement step (only *counting mode*)	⇒ *RUN*
Description of command		FW vers.
These commands have no query form. They start or stop the measurement, setting it to the status given in the top right column.		V3.07

CONFigure:NPOWer:EREPorting <*Mode*>				Event Reporting
<Mode>	Description of parameters	Def. value	Def. unit	FW vers.
SRQ | **SOPC |** **SRSQ |** **OFF**	Service request Single operation complete SRQ and SOPC No reporting	OFF	–	V3.07
Description of command				
This command defines the events generated when the measurement is terminated or stopped *(event reporting,* see chapter 5 of CMU200 operating manual).				

FETCh:NPOWer:STATus?				Measurement Status
Return	Description of parameters	Def. value	Def. unit	FW vers.
OFF |	Measurement in the OFF state (`*RST` or `ABORt`)	OFF	–	V3.07
RUN |	Running (after `INITiate, CONTinue` or `READ`)			
STOP |	Stopped (`STOP`)			
ERR |	OFF (could not be started)			
STEP |	Stepping mode (<stepmode>=STEP)			
RDY,	Stopped according to repetition mode and stop condition			
	Counter for current statistics cycle			
1 to 10000 |	No counting mode set			
NONE		NONE	–	
	Counter for current evaluation period within a cycle			
1 to 1000 |	Statistic count set to off	NONE	–	
NONE				
Description of command				
This command is always a query. It returns the status of the measurement (see chapters 3 and 5 of CMU operating manual).				

Subsystem NPOWer:CONTrol

The subsystem *NPOWer:CONTrol* defines the repetition mode, statistic count, stop condition, and stepping mode of the *NPOWer* measurement.

CONFigure:NPOWer:CONTrol *<Statistics>*, *<Repetition>*,*<StopCond>*,*<Stepmode>*				Scope of Measurement
<Statistics>	Description of parameters	Def. value	Def. unit	
1 to 1000 | **NONE**	No. of evaluation periods within a statistics cycle Statistics off	1	–	
<Repetition>	Description of parameters	Def. value	Def. unit	
CONTinuous | **SINGleshot |** **1 ... 10000**	Continuous measurement (until `STOP` or `ABORT`) Single shot measurement (until `Status = RDY`) Multiple measurement (*counting*, until `Status = STEP | RDY`)	SING	–	
<StopCond>	Description of parameters	Def. value	Def. unit	
SONerror | **NONE**	Start measurement in case of error *(stop on error)* Continue measurement even in case of error	NONE	–	
<Stepmode>	Description of parameters	Def. value	Def. unit	FW vers.
STEP | **NONE**	Interrupt measurement after each statistics cycle Continue measurement according to its rep. mode	NONE	–	V3.07
Description of command				
This command defines the statistic count, repetition mode, stop condition, and stepping mode for the measurement.				

CONFigure:NPOWer:CONTrol:STATistics <*Statistics*> Statistic Count

<Statistics>	Description of parameters	Def. value	Def. unit	FW vers.
1 to 1000 | **NONE**	No. of evaluation periods within a statistics cycle Statistics off	1	–	V3.07

Description of command

This command defines the number of evaluation periods that represent one statistics cycle.

CONFigure:NPOWer:CONTrol:REPetition <*Repetition*>,<*StopCond*>,<*Stepmode*> Test cycles

<Repetition>	Description of parameters	Def. value	Def. unit	
CONTinuous | **SINGleshot |** **1 ... 10000**	Continuous measurement (until `STOP` or `ABORT`) Single shot measurement (until `Status = RDY`) Multiple measurement (*counting*, until `Status = STEP | RDY`)	SING	–	
<StopCond>	Description of parameters	Def. value	Def. unit	
SONerror | **NONE**	Start measurement in case of error *(stop on error)* Continue measurement even in case of error	NONE	–	
<Stepmode>	Description of parameters	Def. value	Def. unit	FW vers.
STEP | **NONE**	Interrupt measurement after each statistics cycle Continue measurement according to its rep. mode	NONE	–	V3.07

Description of command

This command determines the repetition mode, the stop condition and the stepping mode for the measurement.

Note: *In the case of READ commands (`READ:...`), the <Repetition> parameter has no effect; the measurement is always stopped after a single shot.*

Subsystem NPOWer:FREQuency (RBW)

The subsystem *NPOWer:FREQuency* sets the filter bandwidth of the narrow-band power measurement.

[SENSe:]NPOWer:BWIDth[:RESolution] <*Bandwidth*> RBW

<Bandwidth>	Parameter description	Def. value	Default unit	FW vers.
10 Hz to 1 MHz |	Bandwidths of power measurement (the values are rounded in 1 | 2 | 3 | 5 steps)	300 kHz	–	V3.07
TDMA | CDMA	TDMA or CDMA filter			

Command description

This command defines the bandwidth of the power measurement. The TDMA filter is a matched (root-raised cosine) filter specified in standard TIA/EIA-136xxx for the test of modulation parameters. The CDMA filter is a 1.4 MHz bandpass filter specified for cdmaOne and CDMA2000 tests.

Measured Values – Subsystem NPOWer?

The subsystem *NPOWer?* retrieves the results of the narrow-band power measurement (see general information on p. 6.59).

READ[:SCALar]:NPOWer?	Start single shot measurement and return results
FETCh[:SCALar]:NPOWer?	Read out measurement results (unsynchronized)
SAMPle[:SCALar]:NPOWer?	Read out measurement results (synchronized)

Returned values	Value range	Def. value	Def. unit	FW vers.
Avg. Power of Current evaluation period,	–137 dBm to +53 dBm	NAN	dBm	V3.07
Min. Power of Current evaluation period,	–137 dBm to +53 dBm	NAN	dBm	
Max. Power of Current evaluation period,	–137 dBm to +53 dBm	NAN	dBm	
Avg. Power ref. to the last stat. cycle,	–137 dBm to +53 dBm	NAN	dBm	
Min. Power of the entire measurement,	–137 dBm to +53 dBm	NAN	dBm	
Max. Power of the entire measurement	–137 dBm to +53 dBm	NAN	dBm	
Frequency	10 kHz to 2.7 GHz	NAN	Hz	

Description of command

These commands are always queries. They start the *NPOWer* measurement and return the results. As the CMU is capable of determining frequencies with an accuracy of 0.1 Hz, the frequency is returned in exponential representation and with a 10-digit mantissa.

Symbolic Status Event Register Evaluation

The following commands are used to retrieve the events reported in function group *RF*; see section *Symbolic Status Event Register Evaluation* in chapter 5.

STATus:OPERation:SYMBolic:ENABle <Event>{,<Event>} Symbolic status evaluation

Parameter list	Parameter description	Def. Value[7]	Default Unit	FW vers.
<Event>{,<Event>} | **NONE**	List of symbols for events to be reported No event reported	NONE	–	V3.05

Command description

This command enables event reporting for one or several events in the *RF* function group, i.e. it sets the corresponding bits in the `STATus:OPERation:CMU: SUM<nr>:CMU<nr_event>:ENABle` register (`<nr> = 1 | 2, <nr_event>` denotes the RF function group) and in all sum registers up to the status byte. The events and the corresponding symbols for function group *RF* are listed in Chapter 5 (see section *Status Registers)*. The symbols may be entered in arbitrary order.

STATus:OPERation:SYMBolic[:EVENt]? Symbolic status evaluation

Response	Parameter description	Def. Value[8]	Default Unit	FW vers.
NONE | **<Event>{,<Event>}**	No event in the *RF* function group List of reported events	NONE	–	V3.05

Command description

This command is always a query. It lists the events reported in the *RF* function group and deletes these events in the `STATus:OPERation:CMU:SUM<nr> :CMU<nr_event>:EVENt` register as well as in all sum registers.

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[7] The default values quoted in this command are achieved after a `STATus:PRESet` command. `*RST` does not supersede the entries in the status registers; see section *Reset Values of the Status Reporting Systems* in chapter 5.

[8] The default values quoted in this command are achieved after a `*CLS` command. `*RST` does not supersede the entries in the status registers; see section *Reset Values of the Status Reporting Systems* in chapter 5.

Audio Generator and Analyzer (with Option CMU-B41)

Audio measurements form a separate function group (*Non Signalling* mode) with associated secondary address. The *Signalling* mode is not available for audio measurements. However, it is possible to perform audio measurements while using the signalling modes from other function groups (e.g. establish a call to a mobile in function group *GSM900-MS Signalling* and switch over to perform additional audio measurements). Consequently, additional audio-related commands may be provided in other contexts (for example, see the [illegible] and [illegible] ... commands in the *GSM-MS* and other function groups).

The audio function group provides two independent measurements:

- In a single-tone audio measurement, the CMU generates an audio signal at constant level and frequency (see section *AF Generator (AFGenerator* on p. 6.73 ff.) and analyzes a single-tone audio input signal (see section *Audio Analyzer (AFANalyzer)* on p. 6.68 ff.).
- In a multitone measurement (see section *Multitone Measurements (MULTitone* on p. 6.75 ff.), the CMU generates a composite audio signal consisting of up to 20 distinct test tones and analyzes an audio input signal containing the same tones.

Note: *The single-tone generator and the multitone audio measurement must not be running simultaneously. In manual control, this is ensured because the single-tone audio generator is automatically switched off upon swichover to the* Multitone *menu and vice versa. In remote control, the conflict must be resolved explicitly:*

- *The single tone AF generator must be switched off before a multitone measurement is started.*
- *A running multitone measurement must be aborted before the single tone AF generator is switched on.*

In the case of two conflicting audio measurements, the `READ...`, `FETCh...`, `SAMPle...` *commands will result in an error message.*

Two independent audio circuits are provided for both single tone and multitone measurements:

- In the primary audio circuit (subsystems `AFANalyzer[:PRIMary]` and `AFGenerator[:PRIMary]` for single tone measurements, `MULTitone:AF1Channel` for multitone measurements), the audio signals are applied to the connectors AF OUT (output, AF generator signal) and AF IN (input) on the CMU front panel. The `[:PRIMary]` single tone audio circuit corresponds to the *Audio Analyzer/Generator* menu and the associated configuration menu. The `MULTitone:AF1Channel` audio circuit corresponds to the *AF Chan. One* multitone application.
- In the secondary audio circuit (subsystems `AFANalyzer:SECondary` and `AFGenerator:SECondary` for single tone measurements, `MULTitone:AF2Channel` for multitone measurements), the audio signals are applied to the connectors AUX 2 (output, AF generator signal) and AUX 1 (input) on the CMU front panel. The `:SECondary` single tone audio circuit can not be controlled manually. The `MULTitone:AF2Channel` audio circuit corresponds to the *AF Chan. Two* multitone application.

With the exception of the input and output connectors, the two audio circuits are identical. Configurations such as the input path (`AFLevel`) can be set independently. All remote control commands are analogous.

Subsystem Options

The *Options* subsystem contains the commands for querying information on the instrument and the available options. It corresponds to the *Options* tab in the *Setup* menu opened via the *SETUP* key on the front panel.

SYSTem:OPTions:INFO:CURRent?			Device Info
Response	Def. value	Default unit	FW vers.
Example: Rohde&Schwarz,CMU 200-1100.0008.02,840675/018, V3.10C:SP02 2002-09-05"Audio_NSig"	–	–	V3.10
Command description			
This command returns the information on the device comprising the manufacturer, model, serial number and firmware version of the current function group. This command is always a query.			

Configuration File Management – System MMEMory

The `MMEMory` system provides mass storage capabilities for the CMU. The functionality of this system is included in the *Data* menu; see CMU200/300 operating manual.

The mass storage of the CMU may be internal or external. The internal mass storage device is a section on the internal hard disk that is reserved for mass storage (directory c:\temp). The external mass storage device is either a floppy disk or a PCMCIA memory card, depending on the instrument configuration. The *<msus>* (mass storage unit specifier) parameter in the `MMEMory` commands denotes the root directory of the *INTernal* or *EXTernal* mass storage device.

The <FileName> parameter is a string. The contents of the string may contain characters for specifying subdirectories, e.g. "\TEMP\TRASH\test.txt" for the file named *test.txt* in the *TEMP\TRASH* subdirectory of the root directory or "TEMP\TRASH\test.txt" for the file named *test.txt* in the *TEMP\TRASH* subdirectory of the current directory, to be queried with the base system command `MMEMory:DIRectory [:CURRent]?`. The file name itself may contain the period as a separator for extensions.

MMEMory:SAVE:CURRent *<FileName> [,<msus>]*				
	Save configurations in current function group and test mode			
Parameters	Parameter description	Def. value	Def. unit	FW vers.
"<FileName>",	Name of the config. file to be created	–	–	V3.10
INTernal | EXTernal	Storage device of the config. file	INTernal	–	
Command description				
This command saves the configuration of the current function group and test mode to a configuration file. A "?" in the specified file name will be replaced by current numbers that are automatically incremented, starting with zero. The auto-increment function overwrites an existing file with a "9" in its file name. For instrument settings that may be different in manual and remote control (e.g. the repetition mode for many measurements) the manual setting is saved. The command is available in all function groups. This command is CMU-specific.				

MMEMory:RECall:CURRent *<FileName> [,<msus>]*

Recall configurations in current function group and test mode

Parameters	Parameter description	Def. value	Def. unit	FW vers.
"<FileName>", **INTernal | EXTernal**	Name of the config. file to be recalled Storage device of the config. file	– INTernal	– –	V3.10

Command description

This command recalls the configuration of the current function group and test mode from a configuration file. The command is available in all function groups. This command is CMU-specific.

Partial Reset

The `RESet` subsystem restores the (factory) default values for the current function group and test mode. It is similar to the *Reset* menu opened via the *RESET* key on the front panel.

SYSTem:RESet:CURRent Partial Reset

Command description	FW vers.
This command sets all parameters of the current function group and test mode to default values. The command is available in all function groups. In contrast to the *Reset* menu the command restores the default values defined for remote control operation. In cases where remote and manual control use distinct settings (e.g. the repetition mode for many measurements), the manual control settings are left unchanged.	V3.10

Subsystem AFLevel (AF Input Level)

The subsystem `AFLevel` configures the input path for both channels of the single tone and the *Multitone* audio measurement. In manual control the single tone measurement uses the `[:PRIMary]` settings. In the *Multitone* measurement the `AFLevel` subsystem corresponds to the *Analyzer Level* softkey with the hotkeys *Mode* and *AF Max. Level*. Note that the `AFLevel[:PRIMary]` and `AFLevel:SECondary` settings are valid for both single tone and multitone measurements (see table below).

Audio Channel	**Manual Control, Menu**	**Remote control keyword**	**`AFLevel` keyword**
Single tone, channel 1	Analyzer/Generator	`[:PRIMary]`	`[:PRIMary]`
Single tone, channel 2	–	`:SECondary`	`:SECondary`
Multitone, channel 1	Multitone, AF Chan. One	`AF1Channel`	`[:PRIMary]`
Multitone, channel 2	Multitone, AF Chan. Two	`AF2Channel`	`:SECondary`

[SENSe:]AFLevel[:PRIMary]:MODE *<Mode>* Input level – Mode
[SENSe:]AFLevel:SECondary:MODE *<Mode>*

<Mode>	Description of parameters	Def. value	Def. unit	FW vers.
MANual | **AUTomatic**	Manual setting Automatic setting corresponding to average power of signal applied	AUT	–	V3.05

Description of command

This command defines the mode for setting the maximum input level. For firmware versions <3.05, only one `[SENSe:]AFLevel:MODE` command is available to configure all audio channels.

[SENSe:]AFLevel[:PRIMary]:MAXimum *<Level>*
[SENSe:]AFLevel:SECondary:MAXimum *<Level>*
AF Max. Level

<Level>	Description of parameters	Def. value	Def. unit	FW vers.
0 V to +30 V	Maximum audio input voltage	1	V	V3.05

Description of command

This command defines the maximum expected AF input level. For firmware versions <3.05, only one `[SENSe:]AFLevel:MAXimum` command is available to configure all audio channels.

[SENSe:]AFLevel:DEFault
Default Settings

<Enable>	Description of parameters	Def. value	Def. unit	FW vers.
ON | **OFF**	The parameters are set to their default values Some or all parameters differ from the default values	ON	–	V3.0

Description of command

If used as a setting command with the parameter *ON* this command sets all parameters of the subsystem to their default values (the setting OFF results in an error message).

If used as a query the command returns whether all parameters are set to their default values *(ON)* or not *(OFF)*.

Audio Analyzer (AFANalyzer)

The AFANalyzer subsystem measures the single tone audio signal. It corresponds to the *Analyzer* softkey in the main menu *Audio Analyzer/Generator* and the associated output fields.

Subsystem AFANalyzer (Measurement Control)

The subsystem *AFANalyzer* controls the single-tone audio analysis.

INITiate:AFANalyzer[:PRIMary] **INITiate:AFANalyzer:SECondary**	Start new AF measurement	Analyzer ⇒ *RUN*
STOP:AFANalyzer[:PRIMary] **STOP:AFANalyzer:SECondary**	Stop AF measurement after current evaluation period	⇒*STOP*
ABORt:AFANalyzer[:PRIMary] **ABORt:AFANalyzer:SECondary**	Abort and switch off AF analyzer	⇒ *OFF*
CONTinue:AFANalyzer[:PRIMary] **CONTinue:AFANalyzer:SECondary**	Next measurement step (only stepping mode)	⇒ *RUN*

Description of command	FW vers.
These commands have no query form. They start and stop the AF analyzer, setting it to the status given in the top right column.	V2.10

CONFigure:AFANalyzer[:PRIMary]:EREPorting <*Mode*>
CONFigure:AFANalyzer:SECondary:EREPorting <*Mode*>

Event Reporting

<Mode>	Description of parameters	Def. value	Def. unit	FW vers.
SRQ |	Service request	OFF	–	V2.10
SOPC |	Single operation complete			
SRSQ |	SRQ and SRSQ			
OFF	No reporting			

Description of command
This command defines the events generated when the measurement is terminated or stopped (event reporting see chapter 5)

FETCh:AFANalyzer[:PRIMary]:STATus?
FETCh:AFANalyzer:SECondary:STATus?

Measurement Status

Return	Description of parameters	Def. value	Def. unit	FW vers.
OFF |	Measurement in the OFF state (`*RST` or `ABORt`)	OFF	–	V2.10
RUN |	Running (after `INITiate`, `CONTinue` or `READ`)			
STOP |	Stopped (`STOP`)			
ERR |	OFF (could not be started)			
STEP |	Stepping mode (`<stepmode> = STEP`)			
RDY ,	Stopped according to repetition mode and stop condition			
1 to 10000 |	Counter for current statistics cycle			
NONE	No counting mode set	NONE	–	

Description of command
This command is always a query. It returns the status of the measurement (see chapters 3 and 5) and the number of the current statistics cycle.

CONFigure:AFANalyzer[:PRIMary]:MTReduce <Mode>, <Frequency> Reduce Measurement Time
CONFigure:AFANalyzer:SECondary:MTReduce

<Mode>	Description of parameters	Def. value	Def. unit	
LOWF | **EXPF**	Measurement time according to lowest frequency (10 kHz) Measurement time according to *<Frequency>*	LOWF	–	
<Frequency>	**Description of parameters**	**Def. value**	**Def. unit**	**FW vers.**
10 Hz to 20 kHz	Expected frequency of the audio input signal	100	Hz	V3.0

Description of command

This command is to reduce the measurement time the audio analyzer uses to calculate the measurement results *(<Mode>=EXPF);* see section *Subsystem AFANalyzer... (Measured Values)* on page 6.73. The measurement time must be adapted to the period of the input signal, which is the reverse of the frequency. Therefore, the audio measurement can be accelerated for high-frequency signals. In the *LOWF* mode, *<Frequency>* is not taken into account.

Subsystem AFANalyzer...:CONTrol (Control)

The subsystem *AFANalyzer:...CONTrol* defines the scope of the audio analysis and sets the reference frequency for the distortion measurement. The settings are provided in the *Control* and *Distortion* tabs of the *Analyzer Configuration* popup menu.

CONFigure:AFANalyzer[:PRIMary]:CONTrol:REPetition Test Cycles
CONFigure:AFANalyzer:SECondary:CONTrol:REPetition
<Repetition>, <StopCondition>, <Stepmode>

<Repetition>	Description of parameters	Def. value	Def. unit	
CONTinuous | **SINGleshot |** **1 to 10000**	Continuous measurement (until `STOP` or `ABORt`) Single shot measurement (until `Status = RDY`) Multiple measurement (counting, `until Status = STEP | RDY`)	SING	–	
<StopCondition>	**Description of parameters**	**Def. value**	**Def. unit**	
NONE	Continue measurement even in case of error	NONE	–	
<Stepmode>	**Description of parameters**	**Def. value**	**Def. unit**	**FW vers.**
STEP | **NONE**	Interrupt measurement after each statistic cycle Continue measurement according to its rep. mode	NONE	–	V2.10

Description of command

This command determines the number of statistics cycles and the stepping mode for the measurement. A stop condition is not available.

Note*:* *In the case of READ commands (`READ:` to) the <Repetition> parameter has no effect; the measurement is always stopped after a single shot.*

CONFigure:AFANalyzer[:PRIMary]:CONTrol:DISTortion[:FREQuency] *<Frequency>* Frequency
CONFigure:AFANalyzer:SECondary:CONTrol:DISTortion[:FREQuency] *<Frequency>*

<Frequency>	Description of parameters	Def. value	Def. unit	FW vers.
20 Hz to 20000 Hz	Reference frequency for distortion measurement	1000	Hz	V2.10

Description of command

This command determines the reference frequency for the harmonic distortion measurement.

CONFigure:AFANalyzer[:PRIMary]:CONTrol:COUPling *<Coupling>* AF Path Coupling
CONFigure:AFANalyzer:SECondary:CONTrol:COUPling *<Coupling>*

<Coupling>	Description of parameters	Def. value	Def. unit	FW vers.
AC | **DC**	AC coupling of AF path DC coupling of AF path	AC (`[:PRIMary]` channel) DC (`:SECondary` channel)	–	V3.05

Description of command

These commands determine the AF path coupling for measurements using the AF analyzer. In firmware versions <3.05, the commands are replaced by two equivalent `CONFigure:...COUPling` commands.

Subsystem AFANalyzer...:FILTer (Filter)

The subsystem `AFANalyzer...:FILTer` configures the input path of the AF analyzer. The subsystem corresponds to the *Filter* tab in the *Analyzer Configuration* menu. The input path of the AF analyzer is as shown below:

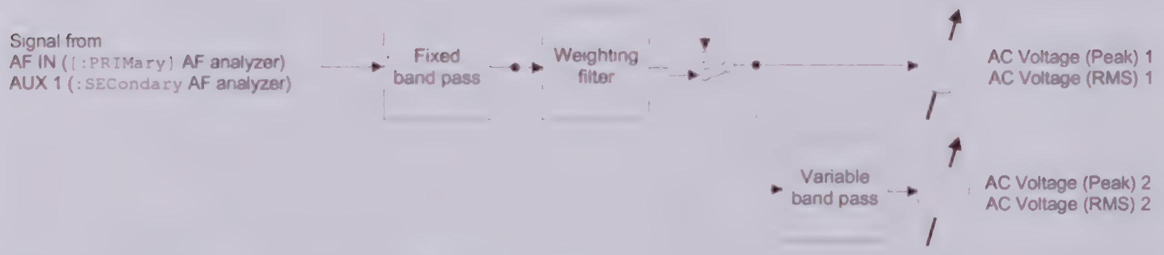
Signal from
AF IN ([:PRIMary] AF analyzer)
AUX 1 (:SECondary AF analyzer)
Fixed band pass
Weighting filter
AC Voltage (Peak) 1
AC Voltage (RMS) 1
Variable band pass
AC Voltage (Peak) 2
AC Voltage (RMS) 2

Fig. 6-1 AF analyzer input path configuration

CONFigure:AFANalyzer[:PRIMary]:FILTer:VBPass:CFRequency *<Center>* Frequency
CONFigure:AFANalyzer:SECondary:FILTer:VBPass:CFRequency *<Center>*

<Center>	Description of parameters	Def. value	Def. unit	FW vers.
20 Hz to 20000 Hz	Center frequency of band pass	1000	Hz	V2.12

Description of command

This command determines the center frequency of the variable band pass.

CONFigure:AFANalyzer[:PRIMary]:FILTer:VBPass:BWIDth *<Bandwidth>*
CONFigure:AFANalyzer:SECondary:FILTer:VBPass:BWIDth *<Bandwidth>*

Bandwidth

<Bandwidth>	Description of parameters	Def. value	Def. unit	FW vers.
10 Hz to 1000 Hz	Bandwidth of band pass	200	Hz	V2.12

Description of command

This command determines the bandwidth of the variable band pass filter.

CONFigure:AFANalyzer[:PRIMary]:FILTer:WEIGhting *<Weighting>*
CONFigure:AFANalyzer:SECondary:FILTer:WEIGhting *<Weighting>*

Weighting Filter

<Weighting>	Description of parameters	Def. value	Def. unit	FW vers.
CME |	Switch on C-message weighted filter	OFF	–	V2.12
CCI |	Switch on CCITT weighting filter			
OFF	No weighting filter			

Description of command

This command selects the weighting filter after the fixed band pass (see *Fig. 6-1*).

Bandwidth (AC Coup.)

CONFigure:AFANalyzer[:PRIMary]:FILTer:BPASs:ACCoupling *<Band pass>*
CONFigure:AFANalyzer:SECondary:FILTer:BPASs:ACCoupling *<Band pass>*

<Band pass>	Description of parameters	Def. value	Def. unit	FW vers.
	CMU band pass filter with a bandwidth of	BP16	–	V3.05
BP01 |	0 Hz to 250 Hz			
BP02 |	6 Hz to 250 Hz			
BP03 |	50 Hz to 250 Hz			
BP04 |	0 Hz to 3000 Hz			
BP05 |	6 Hz to 3000 Hz			
BP06 |	50 Hz to 3000 Hz			
BP07 |	300 Hz to 3000 Hz			
BP08 |	0 Hz to 4000 Hz			
BP09 |	6 Hz to 4000 Hz			
BP10 |	50 Hz to 4000 Hz			
BP11 |	300 Hz to 4000 Hz			
BP12 |	0 Hz to 15000 Hz			
BP13 |	6 Hz to 15000 Hz			
BP14 |	50 Hz to 15000 Hz			
BP15 |	300 Hz to 15000 Hz			
BP16 |	0 Hz to 21000 Hz			
BP17 |	6 Hz to 21000 Hz			
BP18	50 Hz to 21000 Hz			

Description of command

This command selects the first band pass in the AF analyzer to be used if the AF path coupling is set to AC (see `CONFigure:AFANalyzer...:COUPling` command).

Note: *In firmware versions ≥V2.12 but <V3.05, the CONFigure:AFANalyzer... :FILTer:BPASs commands replace the CONFigure:AFANalyzer... :FILTer:BPASs:ACCoupling and CONFigure:AFANalyzer...:FILTer: BPASs:DCCoupling commands. No distinction is made between AC and DC path coupling.*

Bandwidth (DC Coup.)

CONFigure:AFANalyzer[:PRIMary]:FILTer:BPASs:DCCoupling *<Band pass>*
CONFigure:AFANalyzer:SECondary:FILTer:BPASs:DCCoupling *<Band pass>*

<Band pass>	Description of parameters	Def. value	Def. unit	FW vers.
	CMU band pass filter with a bandwidth of	BP17	–	V3.05
BP02 |	6 Hz to 250 Hz			
BP03 |	50 Hz to 250 Hz			
BP05 |	6 Hz to 3000 Hz			
BP06 |	50 Hz to 3000 Hz			
BP07 |	300 Hz to 3000 Hz			
BP09 |	6 Hz to 4000 Hz			
BP10 |	50 Hz to 4000 Hz			
BP11 |	300 Hz to 4000 Hz			
BP13 |	6 Hz to 15000 Hz			
BP14 |	50 Hz to 15000 Hz			
BP15 |	300 Hz to 15000 Hz			
BP17 |	6 Hz to 21000 Hz			
BP18	50 Hz to 21000 Hz			

Description of command

This command selects the first band pass in the AF analyzer to be used if the AF path coupling is set to DC (see `CONFigure:AFANalyzer...:COUPling` command).

Note: *In firmware versions >V2.12 but <V3.05, the CONFigure:AFANalyzer... :FILTer:BPASs commands replace the CONFigure:AFANalyzer... :FILTer:BPASs:ACCoupling and CONFigure:AFANalyzer...:FILTer: BPASs:DCCoupling commands. No distinction is made between AC and DC path coupling. In firmware V3.00, no band pass selection is possible if DC path coupling is set. The CMU always uses a default band pass with a bandwidth of 6 Hz to 21000 Hz (BP17).*

Subsystem AFANalyzer... (Measured Values)

The subsystem *AFANalyzer...* starts the audio analysis and returns the results.

READ[:SCALar]:AFANalyzer[:PRIMary]?	Scalar Results
READ[:SCALar]:AFANalyzer:SECondary?	Start single shot meas. and return results
FETCh[:SCALar]:AFANalyzer[:PRIMary]?	
FETCh[:SCALar]:AFANalyzer:SECondary?	Read out meas. results (unsynchronized)
SAMPle[:SCALar]:AFANalyzer[:PRIMary]?	
SAMPle[:SCALar]:AFANalyzer:SECondary?	Read out meas. results (synchron.)

Return	Description of parameters	Def. value	Def. unit	FW vers.
PeakVoltage1	0 V to 42.4 V	NAN	V	V2.10 V2.12 (last 3 output values)
RMSVoltage1	0 V to 30 V	NAN	V	
DCVoltage	–30 V to 30 V	NAN	V	
Distortion	0% to 100%	NAN	%	
PeakVoltage2	0 V to 42.4 V	NAN	V	
RMSVoltage2	0 V to 30 V	NAN	V	
Frequency	10 Hz to 204.8 kHz	NAN	Hz	

Description of command

These commands are always queries. They start a measurement and output all scalar measurement results (see also Fig. 6-1). These are:

- Peak1 and RMS1 value of AC voltage after first band pass and the weighting filter
- DC voltage
- Total harmonic distortion
- Peak2 and RMS2 value of AC voltage after first band pass and second band pass (variable band pass)
- Frequency counter

AF Generator (AFGenerator)

The subsystem AFGenerator configures and controls the AF generator. It corresponds to the measurement softkey *Generator* in the measurement menu *Audio Analyzer/Generator* and the associated input fields.

INITiate:AFGenerator[:PRIMary]		AF Generator Control
INITiate:AFGenerator:SECondary	Start AF generator, reserve resources	⇒ *RUN*
ABORt:AFGenerator:[PRIMary]		
ABORt:AFGenerator:SECondary	Switch off AF generator, release resources⇒	*OFF*

Description of command	FW vers.
These commands have no query form. They start and stop the AF generator, setting it to the status given in the top right column. **Note:** *A running multitone measurement must be aborted before the single tone AF generator is switched on. See note in section* Audio Generator and Analyzer (with Option CMU-B41) *on page* 6.64.	V2.10

FETCh:AFGenerator[:PRIMary]:STATus?
FETCh:AFGenerator:SECondary:STATus?

Generator Status

Return	Description of parameters	Def. value	Def. unit	FW vers.
OFF |	Generator switched off (`ABORt`, `*RST` or `OFF` due to conflict of resources)	OFF	–	V2.10
RUN |	Running (`INITiate`)			
ERR	Switched off (could not be started)			

Description of command

This command is always a query. It returns the current generator status.

SOURce:AFGenerator[:PRIMary]:LEVel *<Level>*
SOURce:AFGenerator:SECondary:LEVel *<Level>*

Generator Level

<Level>	Description of parameters	Def. value	Def. unit	FW vers.
0 V to 5 V	AF generator voltage	1	V	V2.10

Description of command

This command defines the RMS voltage of the generated AC audio signal or the constant DC voltage, depending on the selected signal type (see command `SOURce:AFGenerator...SMODe`).

SOURce:AFGenerator[:PRIMary]:FREQuency *<Frequency>*
SOURce:AFGenerator:SECondary:FREQuency *<Frequency>*

Frequency

<Frequency>	Description of parameters	Def. value	Def. unit	FW vers.
20 Hz to 20 kHz	AF-Generator frequency	1000	Hz	V2.10

Description of command

This command determines the AF generator frequency.

SOURce:AFGenerator[:PRIMary]:SMODe *<Signal>*
SOURce:AFGenerator:SECondary:SMODe *<Signal>*

Generator Signal

<Frequency>	Description of parameters	Def. value	Def. unit	FW vers.
AF | DC	AF generator signal type	AC	–	V3.10

Description of command

This command determines whether the AF generator signal is an AC or DC signal.

Multitone Measurements (MULTitone)

The subsystem *MULTitone* measures the level of an audio test signal comprising up to 20 test tones. The subsystem corresponds to the measurement menu *Multitone* and the associated popup menu *Multitone Configuration.*

In analogy to the `AFGenerator` and `AFANalyzer` subsystems reported above, the *Multitone* measurement provides two independent circuits:

- In the first audio channel (subsystem `MULTitone:AF1Channel...`), the audio signals are applied to the connectors AF OUT (output, AF generator signal) and AF IN (input) on the CMU front panel. The first audio channel corresponds to the *Multitone* menu, application *AF Chan. One,* and the associated configuration menu.
- In the second audio channel (subsystem `MULTitone:AF2Channel...`), the audio signals are applied to the connectors AUX 2 (output, AF generator signal) and AUX 1 (input) on the CMU front panel. The second audio channel corresponds to the *Multitone* menu, application *AF Chan. Two,* and the associated configuration menu.

With the exception of the input and output connectors, the two audio circuits are identical. All remote control commands are analogous.

Measurement Control – Subsystem MULTitone

The subsystem *MULTitone* controls the measurement. It corresponds to the softkey *AF Chan. One* in the measurement menu *Multitone* and some of the associated hotkeys.

INITiate:MULTitone:AF1Channel **INITiate:MULTitone:AF2Channel**	Start new measurement	⇒ *RUN*
ABORt:MULTitone:AF1Channel **ABORt:MULTitone:AF2Channel**	Abort running measurement and switch off	⇒ *OFF*
STOP:MULTitone:AF1Channel **STOP:MULTitone:AF2Channel**	Stop measurement after current stat. cycle	⇒ *STOP*
CONTinue:MULTitone:AF1Channel **CONTinue:MULTitone:AF2Channel**	Next measurement step (only *stepping mode*)	⇒ *RUN*

Description of command	FW vers.
These commands have no query form. They start and stop the measurement, setting it to the status indicated in the top right column. **Note:** *The single tone AF generator must be switched off before a multitone measurement is started. See note in section* Audio Generator and Analyzer (with Option CMU-B41) 6.64.	V3.0

CONFigure:MULTitone:AF1Channel:EREPorting <*Mode*>
CONFigure:MULTitone:AF2Channel:EREPorting <*Mode*> — Event Reporting

<*Mode*>	Description of parameters	Def. value	Def. unit	FW vers.
SRQ |	Service request	OFF	–	V3.0
SOPC |	Single operation complete			
SRSQ |	SRQ and SOPC			
OFF	No reporting			

Description of command

This command defines the events generated when the measurement is terminated or stopped *(event reporting,* see chapter 5).

FETCh:MULTitone:AF1Channel:STATus? Measurement Status
FETCh:MULTitone:AF2Channel:STATus?

Ret. values	Description of parameters	Def. value	Def. unit	FW vers.
OFF |	Measurement in the *OFF* state (`*RST` or `ABORt`)	OFF	–	V3.0
RUN |	Running (after `INITiate`, `CONTinue` or `READ`)			
STOP |	Stopped (`STOP`)			
ERR |	*OFF* (could not be started)			
STEP |	Stepping mode *(<stepmode>=STEP)*			
RDY,	Stopped according to repetition mode and stop condition			
	Counter for current statistics cycle			
1 to 10000 |	No counting mode set			
NONE		NONE	–	

Description of command

This command is always a query. It returns the status of the measurement (see chapters 3 and 5).

DISPlay:MULTitone:AF1Channel:GRID *<Enable>* Grid on/off
DISPlay:MULTitone:AF2Channel:GRID *<Enable>*

<Enable>	Description of parameters	Def. value	Def. unit	FW vers.
ON |	Switch on grid lines	ON	–	V3.0
OFF	Switch off grid lines			

Description of command

This command switches the grid lines in the test diagrams on or off.

CONFigure:MULTitone:AF1Channel:COUPling *<Coupling>* AF Path Coupling
CONFigure:MULTitone:AF2Channel:COUPling *<Coupling>*

<Coupling>	Description of parameters	Def. value	Def. unit	FW vers.
AC |	AC coupling of AF path	AC (`:AF1Channel`)	–	V3.05
DC	DC coupling of AF path	DC (`:AF2Channel`)		

Description of command

This command determines the AF path coupling for multitone measurements.

CONFigure:MULTitone:AF1Channel:RLEVel *<Voltage>* AF Reference Level
CONFigure:MULTitone:AF2Channel:RLEVel *<Voltage>*

<Voltage>	Description of parameters	Def. value	Def. unit	FW vers.
0.001 V to 5.000 V	Reference Level	0.010	V	V3.0

Description of command

This command defines the AF reference level, i.e. the 0-dB line in the test diagram.

CONFigure:MULTitone:AF1Channel:RMODe *<Reference>* **CONFigure:MULTitone:AF2Channel:RMODe *<Reference>***				Result
<Reference>	Description of parameters	Def. value	Def. unit	FW vers.
RLEV | **TON<nr>**	Results relative to the reference level Results relative to level at test tone <nr>, where <nr> = 1 to 20	TON4	–	V3.0
Description of command				
This command defines the reference value for the results of the *Multitone* measurement. The reference level is defined via `CONFigure:MULTitone:AF1Channel:RLEVel`. To choose one of the test tones no. 1 to 20, it must be enabled via the `CONFigure:MULTitone:AF1Channel:TDEFinition:TONE<nr>` command.				

CONFigure:MULTitone:AF1Channel:AFGLead *<Time>* **CONFigure:MULTitone:AF2Channel:AFGLead *<Time>***				AF Generator Lead
<Time>	Description of parameters	Def. value	Def. unit	FW vers.
0 s to 0.1 s	Hold off time	0.014	s	V3.0
Description of command				
This command defines a hold off time for the AF generator.				

Test Configuration

The commands of the following subsystems configure the *Multitone* measurement. They correspond to the *Multitone Configuration* menu.

Subsystem MULTitone:...CONTrol

The subsystem *MULTitone:...CONTrol* defines the scope of the measurement. It corresponds to the *Control* tab in the popup menu *Multitone Configuration.*

CONFigure:MULTitone:AF1Channel:CONTrol:REPetition **CONFigure:MULTitone:AF2Channel:CONTrol:REPetition** ***<Repetition>, <StopCond>, <Stepmode>***				Test Cycles
<Repetition>	Description of parameters	Def. value	Def. unit	
CONTinuous | **SINGleshot |** **1 to 1000,**	Continuous measurement (until `STOP` or `ABORT`) Single shot measurement (until `Status = RDY`) Multiple measurement (*counting*, until `Status = STEP | RDY`)	SING	–	
<StopCond>	Description of parameters	Def. value	Def. unit	
SONerror | **NONE,**	Stop measurement in case of error *(stop on error)* Continue measurement even in case of error	NONE	–	

<Stepmode>	Description of parameters	Def. value	Def. unit	FW vers.
STEP | NONE	Interrupt measurement after each statistics cycle Continue measurement according to its rep. mode	NONE	–	V3.0

Description of command

This command determines the number of statistics cycles, the stop condition and the stepping mode for the measurement.

Note: *In the case of READ commands ([illegible]...), the <Repetition> parameter has no effect; the measurement is always stopped after a single shot.*

Subsystem SUBarrays:MULTitone:...

The subsystem *SUBarrays:MULTitone:...* defines the measurement range and the type of output values.

CONFigure:SUBarrays:MULTitone:AF1Channel Definition of Subarrays
CONFigure:SUBarrays:MULTitone:AF2Channel
<Mode>,<Start>,<Samples>{,<Start>,<Samples>}

<Mode>	Description of parameters	Def. value	Def. unit	
ALL | ARIThmetical | MINimum | MAXimum | IVAL,	Return all measurement values Return arithm. mean value in every range Return minimum value in every range Return maximum value in every range Return single interpolated value at <Start>	ALL	–	
<Start>	Description of parameters	Def. value	Def. unit	
1 to 20,	Start test tone in current range	1	–	
<Samples>	Description of parameters	Def. value	Def. unit	FW vers.
1 to 20	Number of test tones in current range	20	–	V3.0

Description of command

This command configures the `READ:SUBarrays:MULTitone:AF1Channel...`, `FETCh:SUBarrays:MULTitone:AF1Channel...`, and `SAMPle:SUBarrays:MULTitone:AF1Channel` commands. It restricts the measurement to up to 32 subranges where either all measurement results (the number of which is given by the <Samples> parameter) or a single statistical value is returned.

For <Mode> = IVAL, the <Samples> parameter is ignored and the CMU returns a single measurement value corresponding to the abscissa value <Start>. If <Start> is located between two test points with valid results then the result is calculated from the results at these two adjacent test points by linear interpolation.

The subranges are subsets of the full range of test tones defined via `CONFigure:MULTitone:AF1Channel:TONE<nr>`. Each subrange contains all test tones between the start test tone (test tone no. <Start>) and test tone no. <Start>+<Samples>–1. Test points inside this range that are disabled are not measured (result *NAN)* and do not enter into the ARIThmetical, MINimum and MAXimum values.

By default, only one range corresponding to the total measurement range is used and all measurement values are returned.

Tolerance values – Subsystem MULTitone:...LIMit

The subsystem *MULTitone:...LIMit* defines tolerance values for the *Multitone* measurement. The subsystem corresponds to the *Limits* tab of the popup menu *Multitone Configuration*.

CONFigure:MULTitone:AF1Channel:LIMit:LINE:ASYMmetric:UPPer
CONFigure:MULTitone:AF2Channel:LIMit:LINE:ASYMmetric:UPPer
<Limit_1>, <Enable_1>, ... <Limit_20>, <Enable_20> Upper Limit, Overall

<Limit_nr>	Description of parameters	Def. value	Def. unit	
–80 dB to +80 dB,	Upper limit line at tone <nr>	See below	dB	
<Enable_nr>	Description of parameters	Def. value	Def. unit	FW vers.
ON | OFF	Enable upper limit line at tone <nr>	ON	–	V3.0

Description of command

This command configures the upper limit lines and enables the limit check at the 20 test tones that can be defined via `CONFigure:MULTitone:AF1Channel:TONE<nr>`.

By default, the limit check is switched on at all tones and the following limit lines apply:

Tone <nr>	Limit Line/[dB]	Enable	Tone <nr>	Limit Line/[dB]	Enable
1	–9.5	ON	11	+5.6	ON
2	–6.2	ON	12	+6.3	ON
3	–3.8	ON	13	+6.9	ON
4	–1.9	ON	14	+7.5	ON
5	–0.3	ON	15	+8.0	ON
6	+1.0	ON	16	+8.6	ON
7	+2.1	ON	17	+9.1	ON
8	+3.1	ON	18	+9.6	ON
9	+4.0	ON	19	+10.0	ON
10	+4.8	ON	20	+10.5	ON

CONFigure:MULTitone:AF1Channel:TONE<nr>:LIMit:LINE:ASYMmetric:UPPer
CONFigure:MULTitone:AF2Channel:TONE<nr>:LIMit:LINE:ASYMmetric:UPPer
<Limit>, <Enable> Upper Limit, Single Point

<Limit>	Description of parameters	Def. value	Def. unit	
–80 dB to +80 dB,	Upper limit line at tone <nr>	See below	dB	
<Enable>	Description of parameters	Def. value	Def. unit	FW vers.
ON | OFF	Enable upper limit line at tone <nr>	ON	–	V3.0

Description of command

This command configures the upper limit and enables the limit check at one of 20 test tones that can be defined via `CONFigure:MULTitone:AF1Channel:TONE<nr>`. The test tones are numbered by <nr> = 1 to 20. The default limits at all test points are quoted in the previous command.

CONFigure:MULTitone:AF1Channel:LIMit:LINE:ASYMmetric:LOWer
CONFigure:MULTitone:AF2Channel:LIMit:LINE:ASYMmetric:LOWer
<Limit_1>, <Enable_1>, ... <Limit_20>, <Enable_20> Lower Limits, Overall

<Limit_nr>	Description of parameters	Def. value	Def. unit	
–80 dB to +80 dB,	Lower limit line at tone <nr>	See below	dB	
<Enable_nr>	Description of parameters	Def. value	Def. unit	FW vers.
ON | OFF	Enable lower limit line at tone <nr>	ON	–	V3.0

Description of command

This command configures the lower limit lines and enables the limit check at the 20 test tones that can be defined via `CONFigure:MULTitone:AF1Channel:TONE<nr>`.

By default, the limit check is switched on at all tones and the following limit lines apply:

Tone <nr>	Limit Line/[dB]	Enable	Tone <nr>	Limit Line/[dB]	Enable
1	–13.5	ON	11	+1.6	ON
2	–10.2	ON	12	+2.3	ON
3	–7.8	ON	13	+2.9	ON
4	–5.9	ON	14	+3.5	ON
5	–4.3	ON	15	+4.0	ON
6	–3.0	ON	16	+4.6	ON
7	–1.9	ON	17	+5.0	ON
8	–0.9	ON	18	+5.0	ON
9	0.0	ON	19	+5.0	ON
10	+0.8	ON	20	+5.0	ON

CONFigure:MULTitone:AF1Channel:TONE<nr>:LIMit:LINE:ASYMmetric:LOWer
CONFigure:MULTitone:AF2Channel:TONE<nr>:LIMit:LINE:ASYMmetric:LOWer
<Limit>, <Enable> Lower Limit, Single Point

<Limit>	Description of parameters	Def. value	Def. unit	
–80 dB to +80 dB,	Lower limit line at tone <nr>	See below	dB	
<Enable>	Description of parameters	Def. value	Def. unit	FW vers.
ON | OFF	Enable lower limit line at tone <nr>	ON	–	V3.0

Description of command

This command configures the lower limit and enables the limit check at one of 20 test tones that can be defined via `CONFigure:MULTitone:AF1Channel:TONE<nr>`. The test tones are numbered by <nr> = 1 to 20. The default limits at all test points are quoted in the previous command.

DEFault:MULTitone:AF1Channel:LIMit:LINE *<Enable>* Default Settings
DEFault:MULTitone:AF2Channel:LIMit:LINE *<Enable>*

<Enable>	Description of parameters	Def. value	Def. unit	FW vers.
ON | **OFF**	The parameters are set to their default values Some or all parameters differ from the default values	ON	–	V3.0

Description of command

If used as a setting command with the parameter *ON* this command sets all parameters of the subsystem to their default values (the setting OFF results in an error message).

If used as a query the command returns whether all parameters are set to their default values *(ON)* or not *(OFF)*.

DEFault:MULTitone:LIMit:LINE *<Enable>* Default Settings

<Enable>	Description of parameters	Def. value	Def. unit	FW vers.
ON | **OFF**	The parameters are set to their default values Some or all parameters differ from the default values	ON	–	V3.0

Description of command

If used as a setting command with the parameter *ON* this command sets all parameters of the subsystem (including `AF1Channel` and `AF2Channel`) to their default values (the setting OFF results in an error message). If used as a query the command returns whether all parameters are set to their default values *(ON)* or not *(OFF)*.

Test Tones – Subsystem MULTitone:...TDEFinition

The subsystem *MULTitone:...TDEFinition* configures the audio test signal used for the *Multitone* measurement. The subsystem corresponds to the *Tone Def.* tab of the popup menu *Multitone Configuration.*

CONFigure:MULTitone:AF1Channel:TDEFinition Test Tones
CONFigure:MULTitone:AF2Channel:TDEFinition
<Freq_1>, <Lev_1>, <Enable_1>, ... <Freq_20>, <Lev_20>, <Enable_20>

<Freq_nr>	Description of parameters	Def. value	Def. unit	
10 Hz to 15999 Hz,	Frequency of test tone <nr>	See below	Hz	
<Lev_nr>	Description of parameters	Def. value	Def. unit	
1.0 µV to 5.0 V,	Level at test tone <nr>	See below	V	0
<Enable_nr>	Description of parameters	Def. value	Def. unit	FW vers.
ON | OFF	Switch on / off test tone <nr>	See below	–	V3.0

Description of command

This command enables and configures up to 20 test tones. The minimum frequency spacing between two tones is 1 Hz. The sum of all test tones must not exceed the maximum AF generator level quoted in the data sheet.

The following default test tones are provided:

Tone <nr>	Frequency/[Hz]	Level/[V]	Enable	Tone <nr>	Frequency/[Hz]	Level/[V]	Enable
1	300	0.01	ON	11	1700	0.01	ON
2	440	0.01	ON	12	1840	0.01	ON
3	580	0.01	ON	13	1980	0.01	ON
4	720	0.01	ON	14	2120	0.01	ON
5	860	0.01	ON	15	2260	0.01	ON
6	1004	0.01	ON	16	2400	0.01	ON
7	1140	0.01	ON	17	2540	0.01	ON
8	1280	0.01	ON	18	2680	0.01	ON
9	1420	0.01	ON	19	2820	0.01	ON
10	1560	0.01	ON	20	3000	0.01	ON

Note: *If the level of all test tones is derived from a total level (TLEVel setting in the CONFigure:MULTitone:AF1Channel:TDEFinition:MODE command), the individual level settings are ignored. The* <Frequency> *and* <Enable> *parameter settings are still effective.*

CONFigure:MULTitone:AF1Channel:TDEFinition:TONE<nr>
CONFigure:MULTitone:AF2Channel:TDEFinition:TONE<nr>
<Frequency>, <Level>, <Enable>

Test Tones

<Frequency>	Description of parameters	Def. value	Def. unit	
10 Hz to 15999 Hz,	Frequency of test tone <nr>	See below	Hz	
<Level>	Description of parameters	Def. value	Def. unit	
0.0 V to 5.0 V,	AF level test tone <nr>	See below	V	0
<Enable>	Description of parameters	Def. value	Def. unit	FW vers.
ON | OFF	Switch on / off test tone <nr>	See below	–	V3.0

Description of command

This command enables and configures one of up to 20 test tones (<nr> = 1 to 20) The default values for all test tones are given in the previous command.

Note: *If the level of all test tones is derived from a total level (TLEVel setting in the CONFigure MULTitone AF1Channel TDEFinition MODE command), the* <Level> *setting is ignored. The* <Frequency> *and* <Enable> *parameter setting is still effective.*

CONFigure:MULTitone:AF1Channel:TDEFinition:MODE *<Mode>*
CONFigure:MULTitone:AF2Channel:TDEFinition:MODE *<Mode>*

Level Selection

<Mode>	Description of parameters	Def. value	Def unit	FW vers.
SEParate | **TLEVel**	Use separate levels for each tone Use total level	SEParate	–	V3 0

Description of command

This command defines how the voltage of each of the test tones is determined.

- In the default setting `SEParate`, the levels of all tones are defined separately and may differ from each other (see command `CONFigure:MULTitone:...:TDEFinition` above).
- In the setting `TLEV`, the total AF generator level of 200 mV (see command `CONFigure:MULTitone:...:TDEFinition:TLEVel` below) is evenly distributed among all 20 **enabled** test tones. Test tones can still be enabled or disabled and their frequency can be changed (see `CONF:MULT...:TDEF...` commands above), but level settings will be ignored as long as `TLEV` remains effective.

CONFigure:MULTitone:AF1Channel:TDEFinition:TLEVel *<Total_Level>*
CONFigure:MULTitone:AF2Channel:TDEFinition:TLEVel *<Total_Level>*

Total Level

<Total_Level>	Description of parameters	Def. value	Def. unit	FW vers.
0.0 V to 5.0 V	Total level/voltage (sum of all test tones)	0.200	V	V3.0

Description of command

This command defines the total AF generator level that is evenly distributed among all enabled test tones. The total level setting comes into effect after the level selection mode is set to `TLEV` (see `CONFigure:MULTitone:...TDEFinition:MODe` command above). The total level must not exceed the maximum AF generator level quoted in the data sheet.

DEFault:MULTitone:AF1Channel:TDEFinition *<Enable>*
DEFault:MULTitone:AF2Channel:TDEFinition *<Enable>*

Default Settings

<Enable>	Description of parameters	Def. value	Def. unit	FW vers.
ON | **OFF**	The parameters are set to their default values Some or all parameters differ from the default values	ON	–	V3.0

Description of command

If used as a setting command with the parameter *ON* this command sets all parameters of the subsystem to their default values (the setting OFF results in an error message).

If used as a query the command returns whether all parameters are set to their default values *(ON)* or not *(OFF)*.

DEFault:MULTitone:TDEFinition *<Enable>*

Default Settings

<Enable>	Description of parameters	Def. value	Def. unit	FW vers.
ON | **OFF**	The parameters are set to their default values Some or all parameters differ from the default values	ON	–	V3.0

Description of command

If used as a setting command with the parameter *ON* this command sets all parameters of the subsystem (including `AF1Channel` and `AF2Channel`) to their default values (the setting OFF results in an error message).

If used as a query the command returns whether all parameters are set to their default values *(ON)* or not *(OFF)*.

Path Configuration – Subsystem MULTitone:AF1Channel:FILTer

The subsystem *MULTitone:AF1Channel:FILTer* configures the voice-processing equipment used for the *Multitone* measurement. The subsystem corresponds to the *Filters* tab of the popup menu *Multitone Configuration.*

CONFigure:MULTitone:AF1Channel:FILTer:BPASs:DCCoupling
CONFigure:MULTitone:AF2Channel:FILTer:BPASs:DCCoupling
<Bandpass>

Band Pass, DC Coupling

<Bandpass>	Description of parameters	Def. value	Def. unit	FW vers.
	CMU band pass filter with a bandwidth of	BP17	–	V3.0
BP02 |	6 Hz to 250 Hz			
BP03 |	50 Hz to 250 Hz			
BP05 |	6 Hz to 3000 Hz			
BP06 |	50 Hz to 3000 Hz			
BP07 |	300 Hz to 3000 Hz			
BP09 |	6 Hz to 4000 Hz			
BP10 |	50 Hz to 4000 Hz			
BP11 |	300 Hz to 4000 Hz			
BP13 |	6 Hz to 15000 Hz			
BP14 |	50 Hz to 15000 Hz			
BP15 |	300 Hz to 15000 Hz			
BP17 |	6 Hz to 21000 Hz			
BP18	50 Hz to 21000 Hz			

Description of command

This command selects the band pass filter to be used if the AF path coupling is set to DC (see `CONFigure:AFANalyzer[:PRIMary]:COUPling` command).

CONFigure:MULTitone:AF1Channel:FILTer:BPASs:ACCoupling
CONFigure:MULTitone:AF2Channel:FILTer:BPASs:ACCoupling
<Bandpass>

Band Pass, AC Coupling

<Bandpass>	Description of parameters	Def. value	Def. unit	FW vers.
	CMU band pass filter with a bandwidth of	BP16	–	V3.0
BP01 |	0 Hz to 250 Hz			
BP02 |	6 Hz to 250 Hz			
BP03 |	50 Hz to 250 Hz			
BP04 |	0 Hz to 3000 Hz			
BP05 |	6 Hz to 3000 Hz			
BP06 |	50 Hz to 3000 Hz			
BP07 |	300 Hz to 3000 Hz			
BP08 |	0 Hz to 4000 Hz			
BP09 |	6 Hz to 4000 Hz			
BP10 |	50 Hz to 4000 Hz			
BP11 |	300 Hz to 4000 Hz			
BP12 |	0 Hz to 15000 Hz			
BP13 |	6 Hz to 15000 Hz			
BP14 |	50 Hz to 15000 Hz			
BP15 |	300 Hz to 15000 Hz			
BP16 |	0 Hz to 21000 Hz			
BP17 |	6 Hz to 21000 Hz			
BP 18	50 Hz to 21000 Hz			

Description of command

This command selects the band pass filter to be used if the AF path coupling is set to AC (see `CONFigure:AFANalyzer[:PRIMary]:COUPling` command).

CONFigure:MULTitone:AF1Channel:FILTer:WEIGhting <*Weighting*>
CONFigure:MULTitone:AF2Channel:FILTer:WEIGhting <*Weighting*>

Weighting

<Weighting>	Description of parameters	Def. value	Def. unit	FW vers.
CME |	Switch on C-message weighted filter	OFF	–	V3.0
CCI |	Switch on CCITT weighting filter			
OFF	No weighting filter			

Description of command

This command selects the weighting filter to be included in the AF input signal path.

DEFault:MULTitone:AF1Channel:FILTer <*Enable*>
DEFault:MULTitone:AF2Channel:FILTer <*Enable*>

Default Settings

<Enable>	Description of parameters	Def. value	Def. unit	FW vers.
ON |	The parameters are set to their default values	ON	–	V3.0
OFF	Some or all parameters differ from the default values			

Description of command

If used as a setting command with the parameter *ON* this command sets all parameters of the subsystem to their default values (the setting OFF results in an error message).

If used as a query the command returns whether all parameters are set to their default values *(ON)* or not *(OFF)*.

DEFault:MULTitone:FILTer <*Enable*>

Default Settings

<Enable>	Description of parameters	Def. value	Def. unit	FW vers.
ON |	The parameters are set to their default values	ON	–	V3.0
OFF	Some or all parameters differ from the default values			

Description of command

If used as a setting command with the parameter *ON* this command sets all parameters of the subsystem (including `AF1Channel` and `AF2Channel`) to their default values (the setting OFF results in an error message).

If used as a query the command returns whether all parameters are set to their default values *(ON)* or not *(OFF)*.

Results – Subsystem MULTitone:...?

The subsystem *MULTitone:...?* measures the AF input level, returns the results and compares them with the tolerance values. The subsystem corresponds to the various output elements in the measurement menu *Multitone*.

Multitone Results

READ[:SCALar]:MULTitone:AF1Channel:TONE<nr>?
READ[:SCALar]:MULTitone:AF2Channel:TONE<nr>? Start single shot measurement and return results ⇒ *RUN*
FETCh[:SCALar]:MULTitone:AF1Channel:TONE<nr>?
FETCh[:SCALar]:MULTitone:AF2Channel:TONE<nr>? Read results (unsynchronized) ⇒ *RUN*
SAMPle[:SCALar]:MULTitone:AF1Channel:TONE<nr>?
SAMPle[:SCALar]:MULTitone:AF2Channel:TONE<nr>? Read results (synchronized) ⇒ *RUN*

Returned values	Description of parameters	Def. value	Def. unit	FW vers.
–100.0 dB to +20.0 dB	AF response at point <nr>	NAN	dB	V3.0

Description of command

These commands are always queries They return the audio level at test tones <nr> (<nr> = 1 to 20) defined via `CONFigure:MULTitone:AF1Channel:TONE<nr>`

Multitone Results

READ:ARRay:MULTitone:AF1Channel? Start single shot measurement and return results ⇒ *RUN*
READ:ARRay:MULTitone:AF2Channel?
FETCh:ARRay:MULTitone:AF1Channel? Read meas results (unsynchronized) ⇒ *RUN*
FETCh:ARRay:MULTitone:AF2Channel?
SAMPle:ARRay:MULTitone:AF1Channel? Read results (synchronized) ⇒ *RUN*
SAMPle:ARRay:MULTitone:AF2Channel?

Returned values	Description of parameters	Def. value	Def. unit	FW vers.
–100.0 dB to +20.0 dB,	FreqResp[1], 1st value for AF response	NAN	dB	V3.0
...				
–100.0 dB to +20.0 dB	FreqResp[20], 20th value for AF resp.	NAN	dB	

Description of command

These commands are always queries They return the audio level at the 20 test tones defined via `CONFigure:MULTitone:AF1Channel:TONE<nr>`.

READ:SUBarrays:MULTitone:AF1Channel? Subarray Results
Start single shot measurement and return results ⇒ *RUN*
READ:SUBarrays:MULTitone:AF2Channel?
FETCh:SUBarrays:MULTitone:AF1Channel? Read meas. results (unsynchronized) ⇒ *RUN*
FETCh:SUBarrays:MULTitone:AF2Channel?
SAMPle:SUBarrays:MULTitone:AF1Channel? Read results (synchronized) ⇒ *RUN*
SAMPle:SUBarrays:MULTitone:AF2Channel?

Ret. values per subrange	Description of parameters	Def. value	Def. unit	FW vers.
–100.0 dB to +20.0 dB,	FreqResp[1], 1st value for AF response	NAN	dB	V3.0
...	...	...	...	
–100.0 dB to +20.0 dB	FreqResp[n], nth value for AF response	NAN	dB	

Description of command

These commands are always queries. They return the audio level in the subranges defined by means of the `CONFigure:SUBarrays:MULTitone:AF1Channel` command. In the default setting of the configuration command the `READ:SUBarrays..., FETCh:SUBarrays..., and SAMPle:SUBarrays...` command group is equivalent to the `READ:ARRay..., FETCh:ARRay..., and SAMPle:ARRay...` command group described above.

The `CONFigure:SUBarrays:MULTitone:AF1Channel` command defines a maximum of 32 subranges. If one of the statistical modes `(ARIThmetical, MINimum, MAXimum)` or `IVAL` is set, only one value is returned by subrange.

CALCulate[:SCALar]:MULTitone:AF1Channel:TONE<nr>:MATChing:LIMit? Limit Matching
CALCulate[:SCALar]:MULTitone:AF2Channel:TONE<nr>:MATChing:LIMit?

Returned result	Value range	Def. value	Def. unit	FW vers.
Limit matching at tone <nr>	NMAU | NMAL | INV | OK	INV	–	V3.0

Description of command

This command is always a query. It indicates whether and in which way the error limits at tone <nr> (<nr> = 1 to 20) have been exceeded.

The following messages may be returned for test tone <nr>:

NMAU	Underflow of tolerance value	*not matching, underflow*
NMAL	Tolerance value exceeded	*not matching, overflow*
INV	Measurement invalid	*invalid*
OK	all tolerances matched	

CALCulate[:SCALar]:MULTitone:AF1Channel:MATChing:LIMit? Limit Matching, Overall
CALCulate[:SCALar]:MULTitone:AF2Channel:MATChing:LIMit?

Returned result	Value range	Def. value	Def. unit	FW vers.
Limit matching at tone 1, **...,** **Limit matching at tone 20**	For tones 1 to 20: NMAU | NMAL | INV | OK	INV	–	V3.0

Description of command

This command is always a query. It indicates whether and in which way the error limits at all test tones 1 to 20 have been exceeded. The output string contains 20 values separated by commas.

CALCulate:ARRay:MULTitone:AF1Channel:MATChing:LIMit?
CALCulate:ARRay:MULTitone:AF2Channel:MATChing:LIMit?

Limit Matching, Overall

Returned result	Value range	Def. value	Def. unit	FW vers.
20 bit field,	Indicator for upper limit matching at tone 1 to 20	NAN	–	V3.0
20 bit field	Indicator for lower limit matching at tone 1 to 20	NAN	–	

Description of command

This command is always a query. Any bit of the two returned fields that is set indicates that the limits at the corresponding point are exceeded.

List of Commands

In the following, all remote-control commands of function group *RF Non-Signalling* implemented in the CMU will be listed with their parameters and page numbers. Generally, they are arranged alphabetically according to the **second** keyword of the command so that related commands belong to the same group. For a list of common commands see Table 6-1 in section *Common Commands.*

Table 6-1 List of remote-control commands: CMU base system

Command	Parameters	Remarks	Page
Subsystem COMMunicate (interface parameters)			
SYSTem:COMMunicate:GPIB[:SELF]:ADDRess	0 to 30	with query	6.11
SYSTem:COMMunicate:SERial<1|2>:APPLication	–	query only	6.11
SYSTem:COMMunicate:SERial<1|2>:TRANsmit:PACE	XON|ACK|NONE	with query	6.12
SYSTem:COMMunicate:SERial<1|2>[:RECeive]:BAUD	110 to 115200	with query	6.11
SYSTem:COMMunicate:SERial<1|2>[:RECeive]:BITs	7|8	with query	6.12
SYSTem:COMMunicate:SERial<1|2>[:RECeive]:PARity[:TYPE]	NONE|ODD|EVEN	with query	6.12
SYSTem:COMMunicate:SERial<1|2>[:RECeive]:STOP	1|2	with query	6.12
Subsystem ERRor (error queue)			
SYSTem:ERRor?		query only	6.5
***GTL (Go to Local)**			
*GTL	–	no query	6.15
Subsystem GTRMode (go to remote)			
SYSTem:GTRMode:COMPatible	ON|OFF	with query	6.15
***LLO (local lockout)**			
*LLO	TRUE | FALSe	no query	6.17
Subsystem MISC (keyboard settings)			
SYSTem:MISC:KBEep	ON|OFF	with query	6.14
SYSTem:MISC:KEYBoard	US|GR	with query	6.14
Subsystem MMEMory (mass memory)			
MMEMory:CDIRectory	<DirectoryName>	no query	6.20
MMEMory:COMMent	<Comment>	with query	6.19
MMEMory:COPY	*<FileSource>, <msus1>,* *<FileDest>, <msus2>* | *<FileSource>, <FileDest>*	no query	6.20
MMEMory:DATA?	<FileName> ,<Data>	with query	6.22
MMEMory:DELete	<FileName> [,<msus>]	no query	6.20
MMEMory:DIRectory[:CURRent]?	<DirectoryName>	query only	6.19
MMEMory:INFO?	<FileName> [,<msus>]	query only	6.18
MMEMory:MKDir	<DirName> [,<msus>]	no query	6.20
MMEMory:MOVE	*<FileSource>, <msus1>,* *<FileDest>, <msus2>* | *<FileSource>, <FileDest>*	no query	6.21
MMEMory:MSIS	[<msus>]	with query	6.19
MMEMory:RECall:CURRent	<FileName> [,<msus>]	no query	6.23

Command	**Parameters**	**Remarks**	**Page**
MMEMory:RECall[:ALL]	<FileName> [,<msus>]	no query	6.22
MMEMory:REName	<FileSource>[,<msus1>], <FileDest> [,<msus2>]	no query	6.21
MMEMory:RMDir	<DirName> [,<msus>]	no query	6.20
MMEMory:SAVE:CURRent	<FileName> [,<msus>]	no query	6.22
MMEMory:SAVE[:ALL]	<FileName> [,<msus>]	no query	6.22
MMEMory:SCAN?	INT | EXT, D , <DirectoryName1>,<Directory Name2>,... ,F , <FileName1>,<FileName2>,..	query only	6.21
Subsystem MQueue (measurement queue)			
SYSTem:MQUeue[:COMPlete]:ITEM?	US|GR	query only	6.16
SYSTem:MQUeue[:COMPlete][:LIST]?	<Meas_Queue>	query only	6.15
Subsystem OPTions (options)			
SYSTem:OPTions:INFO:CURRent?		query only	6.25
SYSTem:OPTions:INFO?		query only	6.12
SYSTem:OPTions?		query only	6.13
Subsystem PRESet (general reset)			
SYSTem:PRESet[:ALL]		no query	6.16
SYSTem:RESet:CURRent		no query	6.16
SYSTem:RESet[:ALL]		no query	6.16
Subsystem REMote (remote control)			
SYSTem:REMote:ADDRess:PRIMary	0 to 30	with query	6.10
SYSTem:REMote:ADDRess:SECondary	1 to 29,<Remote-FGrp-Name> | NONe	with query	6.10
*SEC	1 to 29	no query	6.11
System STATus (status reporting system)			
STATus:OPERation:CMU:ALL	0 to 32767, ... , 0 to 32767	query only	6.7
STATus:OPERation:CMU:CLEar	–	no query	6.7
STATus:OPERation:CMU:SUM<nr>:CMU<nr_event>:ENABle	0 to 32767	with query	6.7
STATus:OPERation:CMU:SUM<nr>:CMU<nr_event>[EVENt]?	–	query only	6.6
STATus:OPERation:CMU:SUM<nr>:ENABle	0 to 32767	with query	6.6
STATus:OPERation:CMU:SUM<nr>[EVENt]?		query only	6.6
STATus:OPERation:ENABle	0 to 32767	with query	6.6
STATus:OPERation:EVENt:SADDress?	<SecAddr>,<Fgrp>	query only	6.9
STATus:OPERation:SYMBolic:ENABle	<Event>{,<Event>}	with query	6.9
STATus:OPERation:SYMBolic:ENABle	<Event>{,<Event>}	with query	6.63
STATus:OPERation:SYMBolic[:EVENt]?	NONE | <Event>{,<Event>}	query only	6.9
STATus:OPERation:SYMBolic[:EVENt]?	NONE | <Event>{,<Event>}	query only	6.63
STATus:OPERation[EVENt]?	–	query only	6.6
STATus:PRESet	–	No query	6.7
STATus:QUEStionable:ENABle	0 to 32767	with query	6.7
STATus:QUEStionable[EVENt]?		query only	6.7

Command	Parameters	Remarks	Page
Subsystem SYNChronize (reference frequency)			
CONFigure:SYNChronize:FREQuency:REFerence	10 kHz to 52 MHz	with query	6.23
[SENSe:]SYNChronize:FREQuency:REFerence:LOCKed?	ON | OFF	query only	6.23
CONFigure:SYNChronize:FREQuency:REFerence:MODE	INTernal | EXTernal	with query	6.23
SYSTem (system parameters)			
SYSTem:ERRor?		query only	6.5
SYSTem:NONVolatile:DISable		no query	6.5
SYSTem:VERSion?		query only	6.5
SYSTem:TIMe:DATe	YYYY,MM,DD	with query	6.14
SYSTem:TIMe:TZONe	-12 to +12,-59 to +59	with query	6.13
SYSTem:TIMe[:TIMe]	0 to 23,0 to 59,0 to 59	with query	6.13
TRACe (remote report)			
TRACe:REMote:MODE:DISPlay	ON | OFF	-	6.17
TRACe:REMote:MODE:ERRor	ON | OFF	-	6.17
TRACe:REMote:MODE:FILE	ON | OFF	-	6.17
TRACe:REMote:MODE:OUTLines	1 to 4	-	6.18
TRACe:REMote:MODE:SQR	ON | OFF	-	6.17

Table 6-2 List of remote-control commands: RF measurements

Command	Parameters	Remarks	Page
Subsystem CORRection:LOSS (Ext. Attenuation)			
[SENSe:]CORRection:LOSS:INPut<nr>[:MAGNitude]	–50 dB to 50 dB	with query	6.39
SOURce:CORRection:LOSS:INPut<nr>[:MAGNitude]	–50 dB to 50 dB	with query	6.39
[SENSe:]CORRection:LOSS:OUTPut<nr>:AUXTx[:MAGNitude]	–50 dB to 50 dB	with query	6.40
SOURce:CORRection:LOSS:OUTPut<nr>:AUXTx[:MAGNitude]	–50 dB to 50 dB	with query	6.40
[SENSe:]CORRection:LOSS:OUTPut<nr>[:TX][:MAGNitude]	–50 dB to 50 dB	with query	6.40
SOURce:CORRection:LOSS:OUTPut<nr>[:TX][:MAGNitude]	–50 dB to 50 dB	with query	6.40
SOURce:DM:CLOCk:STATe	ON | OFF	with query	6.40
Subsystem DM:CLOCk (Synchronization)			
SOURce:DM:CLOCk:FREQuency	1.250 MHz to 40.000 MHz	with query	6.41
SOURce:DM:CLOCk:STATe	ON | OFF	with query	6.40
Subsystem INPut, OUTput (⊕)			
INPut[:STATe]	ON | OFF	with query	6.39
OUTPut[:STATe]	ON | OFF	with query	6.39
Subsystem IQIF (I/Q-IF Signals)			
IQIF:DEFault	ON | OFF	with query	6.43
CONFigure:IQIF:RXPath	BYP | BYIQ | XOIO | IOIO | IOXO	with query	6.42
CONFigure:IQIF:RXTXcombined	BYP | BYIQ | XOIO | IOIO | IOXO | FPAT | UDEF	with query	6.42

Command	Parameters	Remarks	Page
CONFigure:IQIF:TXPath	BYP | BYIQ | XOIO | IOIO | IOXO	with query	6.42
Subsystem LEVel (Input Level)			
[SENSe:]LEVel:ATTenuation	NORMal | LNOise | LDIStortion	with query	6.27
[SENSe:]LEVel:DEFault	ON | OFF	with query	6.27
[SENSe:]LEVel:MAXimum	–37 dBm to +53 dBm	depending on input and ext. attenuation set	6.26
[SENSe:]LEVel:MODE	MANual | AUTO	with query	6.27
[SENSe:]LEVel:REFerence	–100 dBm to +53 dBm	depending on input and ext. attenuation set	6.27
Subsystem NPOWer (narrow-band power)			
INITiate:NPOWer	–	no query	6.59
ABORt:NPOWer	–	no query	6.59
STOP:NPOWer	–	no query	6.59
CONTinue:NPOWer	–	no query	6.59
[SENSe:]NPOWer:BWIDth[:RESolution]	10 Hz to 1 MHz	with query	6.61
CONFigure:NPOWer:CONTrol	1 to 1000 | NONE,CONTinuous | SINGleshot | 1 ... 10000, SONerror | NONE,STEP | NONE	with query	6.60
CONFigure:NPOWer:CONTrol:REPetition	CONTinuous | SINGleshot | 1 ... 10000, SONerror | NONE,STEP | NONE	with query	6.61
CONFigure:NPOWer:CONTrol:STATistics	1 to 1000 | NONE	with query	6.61
CONFigure:NPOWer:EREPorting	SRQ | SOPC | SRSQ | OFF	with query	6.59
FETCh:NPOWer:STATus?	OFF | RUN | STOP | ERR | STEP | RDY, 1 to 10000 | NONE, 1 to 1000 | NONE	query only	6.60
READ[:SCALar]:NPOWer?	–30 dBm to +30 dBm	query only	6.62
FETCh[:SCALar]:NPOWer?	–30 dBm to +30 dBm	query only	6.62
SAMPle[:SCALar]:NPOWer?	–30 dBm to +30 dBm	query only	6.62
Test object POWer (Power)			
INITiate:POWer	–	no query	6.44
ABORt:POWer	–	no query	6.44
STOP:POWer	–	no query	6.44
CONTinue:POWer	–	no query	6.44
CONFigure:SUBarrays:POWer	ALL | ARIThmetical | MINimum | MAXimum | IVAL,<Start>,<Samples>{,<Start>,<Samples>}	with query	6.48
READ:ARRay:POWer:AVERage?	–128.0 dBm to +48.0 dBm	query only	6.49
FETCh:ARRay:POWer:AVERage?	–128.0 dBm to +48.0 dBm	query only	6.49
SAMPle:ARRay:POWer:AVERage?	–128.0 dBm to +48.0 dBm	query only	6.49
READ:SUBarrays:POWer:AVERage?	–128.0 dBm to +48.0 dBm	query only	6.50
FETCh:SUBarrays:POWer:AVERage?	–128.0 dBm to +48.0 dBm	query only	6.50
SAMPle:SUBarrays:POWer:AVERage?	–128.0 dBm to +48.0 dBm	query only	6.50
CONFigure:POWer:CONTrol	SCALar | ARRay	with query	6.45

Command	Parameters	Remarks	Page
CONFigure:POWer:CONTrol:REPetition	CONTinuous | SINGleshot | 1 to 10000, NONE,STEP | NONE	with query	6.45
CONFigure:POWer:EREPorting	SRQ | SOPC | SRSQ | OFF	with query	6.44
[SENSe:]POWer:FREQuency:BANDwidth[:RESolution]	10 Hz to 1 MHz	with query	6.46
[SENSe:]POWer:FREQuency:BWIDth[:RESolution]	10 Hz to 1 MHz	with query	6.46
[SENSe:]POWer:FREQuency:CENTer	10 kHz to 2.7 GHz	with query	6.46
[SENSe:]POWer:LEVel:RANGe	10.0 dB to 100.0 dB	with query	6.46
READ:ARRay:POWer:MAXimum?	–128.0 dBm to +48.0 dBm	query only	6.49
FETCh:ARRay:POWer:MAXimum?	–128.0 dBm to +48.0 dBm	query only	6.49
SAMPle:ARRay:POWer:MAXimum?	–128.0 dBm to +48.0 dBm	query only	6.49
READ:SUBarrays:POWer:MAXimum?	–128.0 dBm to +48.0 dBm	query only	6.50
FETCh:SUBarrays:POWer:MAXimum?	–128.0 dBm to +48.0 dBm	query only	6.50
SAMPle:SUBarrays:POWer:MAXimum?	–128.0 dBm to +48.0 dBm	query only	6.50
READ:ARRay:POWer:MINimum?	–128.0 dBm to +48.0 dBm	query only	6.49
READ:ARRay:POWer:MINimum?	–128.0 dBm to +48.0 dBm	query only	6.49
FETCh:ARRay:POWer:MINimum?	–128.0 dBm to +48.0 dBm	query only	6.49
FETCh:ARRay:POWer:MINimum?	–128.0 dBm to +48.0 dBm	query only	6.49
SAMPle:ARRay:POWer:MINimum?	–128.0 dBm to +48.0 dBm	query only	6.49
READ:SUBarrays:POWer:MINimum?	–128.0 dBm to +48.0 dBm	query only	6.50
READ:SUBarrays:POWer:MINimum?	–128.0 dBm to +48.0 dBm	query only	6.50
FETCh:SUBarrays:POWer:MINimum?	–128.0 dBm to +48.0 dBm	query only	6.50
FETCh:SUBarrays:POWer:MINimum?	–128.0 dBm to +48.0 dBm	query only	6.50
SAMPle:SUBarrays:POWer:MINimum?	–128.0 dBm to +48.0 dBm	query only	6.50
FETCh:POWer:STATus?	OFF | RUN | STOP | ERR | STEP | RDY, 0 to 10000 | NONE , 0 to 1000 | NONE	query only	6.44
[SENSe:]POWer:TIME:DELay	-1000.0 µs to +1000.0 µs	depending on span and bandwidth	6.47
[SENSe:]POWer:TIME:SPAN	10 µs to 10 s	depending on bandwidth	6.47
READ:ARRay:POWer[:CURRent]?	–128.0 dBm to +48.0 dBm	query only	6.49
FETCh:ARRay:POWer[:CURRent]?	–128.0 dBm to +48.0 dBm	query only	6.49
SAMPle:ARRay:POWer[:CURRent]?	–128.0 dBm to +48.0 dBm	query only	6.49
READ:SUBarrays:POWer[:CURRent]?	–128.0 dBm to +48.0 dBm	query only	6.50
FETCh:SUBarrays:POWer[:CURRent]?	–128.0 dBm to +48.0 dBm	query only	6.50
SAMPle:SUBarrays:POWer[:CURRent]?	–128.0 dBm to +48.0 dBm	query only	6.50
Subsystem OPTions (options)			
SYSTem:OPTions:INFO:CURRent?		query only	6.25
Save/Recall of settings			
MMEMory:RECall:CURRent	<FileName> [,<msus>]	no query	6.26
MMEMory:SAVE:CURRent	<FileName> [,<msus>]	no query	6.25
Partial reset			
SYSTem:RESet:CURRent	–	no query	6.26
Test object RFANalyzer (Power)			
INITiate:RFANalyzer	–	no query	6.30

Command	Parameters	Remarks	Page
ABORt:RFANalyzer	–	no query	6.30
STOP:RFANalyzer	–	no query	6.30
CONTinue:RFANalyzer	–	no query	6.30
[SENSe:]RFANalyzer:BANDwidth[:RESolution]	10 Hz to 1 MHz | WIDE	with query	6.30
[SENSe:]RFANalyzer:BWIDth[:RESolution]	10 Hz to 1MHz | WIDE	with query	6.30
CONFigure:RFANalyzer:CONTrol:REPetition	CONTinuous | SINGleshot | 1 to 10000, NONE,STEP | NONE	with query	6.32
CONFigure:RFANalyzer:EREPorting	SRQ | SOPC | SRSQ | OFF	with query	6.31
[SENSe:]RFANalyzer:FREQuency	100 kHz to 2.7 GHz	with query	6.30
CONFigure:RFANalyzer:POWer:RTIMe	0 to xxx	with query	6.32
READ[:SCALar]:RFANalyzer:POWer?	-120.0 dBm to +47.0 dBm	query only	6.32
FETCh[:SCALar]:RFANalyzer:POWer?	-120.0 dBm to +47.0 dBm	query only	6.32
SAMPle[:SCALar]:RFANalyzer:POWer?	-120.0 dBm to +47.0 dBm	query only	6.32
FETCh:RFANalyzer:STATus?	OFF | RUN | STOP | ERR | STEP | RDY, 0 to 10000 | NONE , 0 to 1000 | NONE	query only	6.31
Generator object RFGenerator			
DEFault:RFGenerator	ON | OFF	with query	6.33
INITiate:RFGenerator	–	no query	6.33
ABORt:RFGenerator	–	no query	6.33
CONFigure:RFGenerator:APPLication	TX | AUXT | TXAT	with query	6.33
DEFault:RFGenerator:AUXTx	ON | OFF	with query	6.38
SOURce:RFGenerator:AUXTx: FREQuency	350 MHz to 550 MHz | 700 MHz to 1100 MHz | 1400 MHz to 2200 MHz	with query	6.38
SOURce:RFGenerator:AUXTx:LEVel	-137.0 dBm to + 13.0 dBm	restricted for RF1 / 2	6.38
SOURce:RFGenerator:BANDwidth	OFF | F30Khz | F300khz	with query	6.37
SOURce:RFGenerator:BWIDth	<Bandwidth>	with query	6.37
SOURce:RFGenerator:FHOPping:FREQuency	100.0 kHz to 2.7 GHz	with query	6.36
SOURce:RFGenerator:FHOPping:FREQuency:MODE	ABSolute | RELative	with query	6.36
SOURce:RFGenerator:FHOPping:STATe	OFF | ON	with query	6.36
SOURce:RFGenerator:MODulation	OFF | SSB | AM	with query	6.35
SOURce:RFGenerator:MODulation:SSB:FREQuency	-300 kHz to +300 kHz	with query	6.35
SOURce:RFGenerator:MODulation[:AM]:INDex	0% to 100%	with query	6.35
SOURce:RFGenerator:PULSe:STATe	OFF | ON	with query	6.37
FETCh:RFGenerator:STATus?	OFF | RUN | ERR	query only	6.34
DEFault:RFGenerator:TX	ON | OFF	with query	6.33
SOURce:RFGenerator[:TX]:FREQuency	100.0 kHz to 2.7 GHz	with query	6.34
SOURce:RFGenerator[:TX]:LEVel	-137.0 dBm to + 13.0 dBm	restricted for RF1 / 2	6.34
Test object SPECtrum			
INITiate:SPECtrum	–	no query	6.51
ABORt:SPECtrum	–	no query	6.51
STOP:SPECtrum	–	no query	6.51
CONTinue:SPECtrum	–	no query	6.51
CONFigure:SUBarrays:SPECtrum	ALL | ARIThmetical | MINimum	with query	6.54

Command	Parameters	Remarks	Page
	| MAXimum | IVAL,<Start>,<Samples>{,<Start>,<Samples>}		
READ:ARRay:SPECtrum:AVERage?	–128.0 dBm to +48.0 dBm	query only	6.55
FETCh:ARRay:SPECtrum:AVERage?	–128.0 dBm to +48.0 dBm	query only	6.55
SAMPle:ARRay:SPECtrum:AVERage?	–128.0 dBm to +48.0 dBm	query only	6.55
READ:SUBarrays:SPECtrum:AVERage?	–128.0 dBm to +48.0 dBm	query only	6.56
FETCh:SUBarrays:SPECtrum:AVERage?	–128.0 dBm to +48.0 dBm	query only	6.56
SAMPle:SUBarrays:SPECtrum:AVERage?	–128.0 dBm to +48.0 dBm	query only	6.56
CONFigure:SPECtrum:CONTrol	SCALar | ARRay, 1 to 1000 | NONE	with query	6.52
CONFigure:SPECtrum:CONTrol:REPetition	CONTinuous | SINGleshot | 1 to 10000, NONE, STEP | NONE	with query	6.53
[SENSe:]SPECtrum:DETector	PEAK | RMS	with query	6.52
CONFigure:SPECtrum:EREPorting	SRQ | SOPC | SRSQ | OFF	with query	6.51
[SENSe:]SPECtrum:FREQuency:BANDwidth[:RESolution]	10 Hz to 1 MHz | AUTO	with query	6.53
[SENSe:]SPECtrum:FREQuency:BWIDth[:RESolution]	10 Hz to 1 MHz | AUTO	with query	6.53
[SENSe:]SPECtrum:FREQuency:CENTer	10.000005 MHz to 2.699999995 GHz	with query	6.53
[SENSe:]SPECtrum:FREQuency:SPAN	0.00001 MHz to 2.69999999 GHz	with query	6.53
[SENSe:]SPECtrum:FREQuency:STARt	10 MHz to 2.69999999 GHz	with query	6.53
[SENSe:]SPECtrum:FREQuency:STOP	10.00001 MHz to 2.7 GHz	with query	6.53
[SENSe:]SPECtrum:LEVel:RANGe	10 dB to 100 dB	with query	6.54
READ:ARRay:SPECtrum:MAXimum?	–128.0 dBm to +48.0 dBm	query only	6.55
FETCh:ARRay:SPECtrum:MAXimum?	–128.0 dBm to +48.0 dBm	query only	6.55
SAMPle:ARRay:SPECtrum:MAXimum?	–128.0 dBm to +48.0 dBm	query only	6.55
READ:SUBarrays:SPECtrum:MAXimum?	–128.0 dBm to +48.0 dBm	query only	6.56
FETCh:SUBarrays:SPECtrum:MAXimum?	–128.0 dBm to +48.0 dBm	query only	6.56
SAMPle:SUBarrays:SPECtrum:MAXimum?	–128.0 dBm to +48.0 dBm	query only	6.56
READ:ARRay:SPECtrum:MINimum?	–128.0 dBm to +48.0 dBm	query only	6.55
READ:ARRay:SPECtrum:MINimum?	–128.0 dBm to +48.0 dBm	query only	6.55
FETCh:ARRay:SPECtrum:MINimum?	–128.0 dBm to +48.0 dBm	query only	6.55
FETCh:ARRay:SPECtrum:MINimum?	–128.0 dBm to +48.0 dBm	query only	6.55
SAMPle:ARRay:SPECtrum:MINimum?	–128.0 dBm to +48.0 dBm	query only	6.55
READ:SUBarrays:SPECtrum:MINimum?	–128.0 dBm to +48.0 dBm	query only	6.56
READ:SUBarrays:SPECtrum:MINimum?	–128.0 dBm to +48.0 dBm	query only	6.56
FETCh:SUBarrays:SPECtrum:MINimum?	–128.0 dBm to +48.0 dBm	query only	6.56
FETCh:SUBarrays:SPECtrum:MINimum?	–128.0 dBm to +48.0 dBm	query only	6.56
SAMPle:SUBarrays:SPECtrum:MINimum?	–128.0 dBm to +48.0 dBm	query only	6.56
FETCh:SPECtrum:STATus?	OFF | RUN | STOP | ERR | STEP | RDY, 0 to 10000 | NONE , 0 to 1000 | NONE	query only	6.51
READ:ARRay:SPECtrum[:CURRent]?	–128.0 dBm to +48.0 dBm	query only	6.55
FETCh:ARRay:SPECtrum[:CURRent]?	–128.0 dBm to +48.0 dBm	query only	6.55
SAMPle:ARRay:SPECtrum[:CURRent]?	–128.0 dBm to +48.0 dBm	query only	6.55
READ:SUBarrays:SPECtrum[:CURRent]?	–128.0 dBm to +48.0 dBm	query only	6.56
FETCh:SUBarrays:SPECtrum[:CURRent]?	–128.0 dBm to +48.0 dBm	query only	6.56

Command	Parameters	Remarks	Page
SAMPle:SUBarrays:SPECtrum[:CURRent]?	–128.0 dBm to +48.0 dBm	query only	6.56
System STATus (status reporting system)			
STATus:OPERation:SYMBolic[:EVENt]?	NONE | <Event>{,<Event>}	query only	6.63
STATus:OPERation:SYMBolic:ENABle	<Event>{,<Event>}	with query	6.63
Subsystem TRIGger			
TRIGger[:SEQuence]:DEFault	ON | OFF	with query	6.29
TRIGger[:SEQuence]:SLOPe	POSitive | NEGative	with query	6.28
TRIGger[:SEQuence]:SOURce	IMMediate | RFPower | IFPower | EXTern	with query	6.28
TRIGger[:SEQuence]:SOURce:EXTernal	PIN6 | PIN7 | PIN8	with query	6.29
TRIGger[:SEQuence]:THReshold:IFPower	<Threshold>	with query	6.28
TRIGger[:SEQuence]:THReshold:RFPower	LOW | MEDium | HIGH	with query	6.28
TRIGger[:SEQuence]:DEFault	ON | OFF	with query	6.31
TRIGger[:SEQuence]:SLOPe	POSitive | NEGative	with query	6.30
TRIGger[:SEQuence]:SOURce	IMMediate | RFPower | IFPower | EXTern	with query	6.30
TRIGger[:SEQuence]:SOURce:EXTernal	PIN6 | PIN7 | PIN8	with query	6.31
TRIGger[:SEQuence]:THReshold:IFPower	<Threshold>	with query	6.30
TRIGger[:SEQuence]:THReshold:RFPower	LOW | MEDium | HIGH	with query	6.30
Subsystem WPOWer (wideband power)			
INITiate:WPOWer	–	no query	6.57
ABORt:WPOWer	–	no query	6.57
STOP:WPOWer	–	no query	6.57
CONTinue:WPOWer	–	no query	6.57
CONFigure:WPOWer:CONTrol:REPetition	CONTinuous | SINGleshot | 1 ... 10000, SONerror | NONE,STEP | NONE	with query	6.58
CONFigure:WPOWer:EREPorting	SRQ | SOPC | SRSQ | OFF	with query	6.57
FETCh:WPOWer:STATus?	OFF | RUN | STOP | ERR | STEP | RDY, 1 ... 10000 | NONE	query only	6.57
READ[:SCALar]:WPOWer?	<Result>	query only	6.58
FETCh[:SCALar]:WPOWer?	<Result>	query only	6.58
SAMPle[:SCALar]:WPOWer?	<Result>	query only	6.58

Table 6-3 List of remote-control commands: Audio Measurements

Command	Parameters	Remarks	Page
Subsystem AFANalyzer			
INITiate:AFANalyzer:SECondary	–	no query	6.68
STOP:AFANalyzer:SECondary	–	no query	6.68
STOP:AFANalyzer:SECondary	–	no query	6.68
ABORt:AFANalyzer:SECondary	–	no query	6.68
CONTinue:AFANalyzer:SECondary	–	no query	6.68

Command	Parameters	Remarks	Page
CONFigure:AFANalyzer:SECondary:CONTrol:COUPling	AC | DC	with query	6.70
CONFigure:AFANalyzer:SECondary:CONTrol:DISTortion [:FREQuency]	100 Hz to 10000 Hz	with query	6.70
CONFigure:AFANalyzer:SECondary:CONTrol:REPetition	CONTinuous | SINGleshot | 1 to 10000, SONerror | NONE, STEP | NONE	with query	6.69
CONFigure:AFANalyzer:SECondary:EREPorting	SRQ | SOPC | SRSQ | OFF	with query	6.68
CONFigure:AFANalyzer:SECondary:FILTer:BPASs:ACCoupling	BP01 to BP18	with query	6.71
CONFigure:AFANalyzer:SECondary:FILTer:BPASs:DCCoupling	BP01 to BP18	with query	6.72
CONFigure:AFANalyzer:SECondary:FILTer:VBPass:BWIDth	10 Hz to 1000 Hz	with query	6.71
CONFigure:AFANalyzer:SECondary:FILTer:VBPass :CFRequency	20 Hz to 20000 Hz	with query	6.70
CONFigure:AFANalyzer:SECondary:FILTer:WEIGhting	CME | CCI | OFF	with query	6.71
CONFigure:AFANalyzer:SECondary:MTReduce	LOWF | EXPF, <Frequency>	with query	6.69
FETCh:AFANalyzer:SECondary:STATus?	OFF | RUN | STOP | ERR | STEP | RDY, 1 to 10000 | NONE	query only	6.68
READ[:SCALar]:AFANalyzer:SECondary?	–	query only	6.73
FETCh[:SCALar]:AFANalyzer:SECondary?	–	query only	6.73
SAMPle[:SCALar]:AFANalyzer:SECondary?	–	query only	6.73
INITiate:AFANalyzer[:PRIMary]	–	no query	6.68
ABORt:AFANalyzer[:PRIMary]	–	no query	6.68
CONTinue:AFANalyzer[:PRIMary]	–	no query	6.68
CONFigure:AFANalyzer[:PRIMary]:CONTrol:COUPling	AC | DC	with query	6.70
CONFigure:AFANalyzer[:PRIMary]:CONTrol:DISTortion [:FREQuency]	100 Hz to 10000 Hz	with query	6.70
CONFigure:AFANalyzer[:PRIMary]:CONTrol:REPetition	CONTinuous | SINGleshot | 1 to 10000, SONerror | NONE, STEP | NONE	with query	6.69
CONFigure:AFANalyzer[:PRIMary]:EREPorting	SRQ | SOPC | SRSQ | OFF	with query	6.68
CONFigure:AFANalyzer[:PRIMary]:FILTer:BPASs:ACCoupling	BP01 to BP18	with query	6.71
CONFigure:AFANalyzer[:PRIMary]:FILTer:BPASs:DCCoupling	BP01 to BP18	with query	6.72
CONFigure:AFANalyzer[:PRIMary]:FILTer:VBPass:BWIDth	10 Hz to 1000 Hz	with query	6.71
CONFigure:AFANalyzer[:PRIMary]:FILTer:VBPass:CFRequency	20 Hz to 20000 Hz	with query	6.70
CONFigure:AFANalyzer[:PRIMary]:FILTer:WEIGhting	CME | CCI | OFF	with query	6.71
CONFigure:AFANalyzer[:PRIMary]:MTReduce	LOWF | EXPF, <Frequency>	query only	6.69
FETCh:AFANalyzer[:PRIMary]:STATus?	OFF | RUN | STOP | ERR | STEP | RDY, 1 to 10000 | NONE	query only	6.68
READ[:SCALar]:AFANalyzer[:PRIMary]?	–	query only	6.73
FETCh[:SCALar]:AFANalyzer[:PRIMary]?	–	query only	6.73
SAMPle[:SCALar]:AFANalyzer[:PRIMary]?	–	query only	6.73
Subsystem AFGenerator			
INITiate:AFGenerator:SECondary	–	no query	6.73
ABORt:AFGenerator:SECondary	–	no query	6.73
SOURce:AFGenerator:SECondary:FREQuency	20 Hz to 20 kHz	with query	6.74
SOURce:AFGenerator:SECondary:LEVel	0 µV to 5 V	with query	6.74
SOURce:AFGenerator:SECondary:SMODe	20 Hz to 20 kHz	with query	6.74
FETCh:AFGenerator:SECondary:STATus?	OFF | RUN | ERR	query only	6.74

Command	Parameters	Remarks	Page
INITiate:AFGenerator[:PRIMary]	–	no query	6.73
ABORt:AFGenerator[:PRIMary]	–	no query	6.73
SOURce:AFGenerator[:PRIMary]:FREQuency	20 Hz to 20 kHz	with query	6.74
SOURce:AFGenerator[:PRIMary]:LEVel	0 µV to 5 V	with query	6.74
SOURce:AFGenerator[:PRIMary]:SMODe	20 Hz to 20 kHz	with query	6.74
FETCh:AFGenerator[:PRIMary]:STATus?	OFF | RUN | ERR	query only	6.74
Subsystem AFLevel (AF input level)			
[SENSe:]AFLevel:DEFault	ON | OFF	with query	6.67
[SENSe:]AFLevel:SECondary:MAXimum	<Level>	with query	6.67
[SENSe:]AFLevel:SECondary:MODE	MANual | AUTO	with query	6.66
[SENSe:]AFLevel[:PRIMary]:MAXimum	<Level>	with query	6.67
[SENSe:]AFLevel[:PRIMary]:MODE	MANual | AUTO	with query	6.66
Save/Recall of settings			
MMEMory:RECall:CURRent	<FileName> [,<msus>]	no query	6.65
MMEMory:SAVE:CURRent	<FileName> [,<msus>]	no query	6.66
Subsystem MULTitone			
INITiate:MULTitone:AF1Channel	–	no query	6.75
ABORt:MULTitone:AF1Channel	–	no query	6.75
STOP:MULTitone:AF1Channel	–	no query	6.75
CONTinue:MULTitone:AF1Channel	–	no query	6.75
CONFigure:SUBarrays:MULTitone:AF1Channel	ALL | ARITHmetical | MINimum | MAXimum | IVAL,<Range>{,<Range>}	with query	6.78
CONFigure:MULTitone:AF1Channel:AFGLead	0 s to 0.1 s	with query	6.77
CONFigure:MULTitone:AF1Channel:CONTrol	AC | DC	with query	6.76
CONFigure:MULTitone:AF1Channel:CONTrol:REPetition	CONTinuous | SINGleshot | 1 to 1000, SONerror | NONE, STEP | NONE	with query	6.77
CONFigure:MULTitone:AF1Channel:EREPorting	SRQ | SOPC | SRSQ | OFF	with query	6.75
DEFault:MULTitone:AF1Channel:FILTer	ON | OFF	with query	6.85
CONFigure:MULTitone:AF1Channel:FILTer:BPASs:ACCoupling	*<Bandpass>*	with query	6.84
CONFigure:MULTitone:AF1Channel:FILTer:BPASs:DCCoupling	*<Bandpass>*	with query	6.84
CONFigure:MULTitone:AF1Channel:FILTer:WEIGhting	*<Weighting>*	with query	6.85
DISPlay:MULTitone:AF1Channel:GRID	ON | OFF	with query	6.76
DEFault:MULTitone:AF1Channel:LIMit:LINE	ON | OFF	with query	6.80
CONFigure:MULTitone:AF1Channel:LIMit:LINE:ASYMmetric :LOWer	*<Limit_1>, <Enable_1>, ... <Limit_20>, <Enable_20>*	with query	6.80
CONFigure:MULTitone:AF1Channel:LIMit:LINE:ASYMmetric :UPPer	*<Limit_1>, <Enable_1>, ... <Limit_20>, <Enable_20>*	with query	6.79
CALCulate[:SCALar]:MULTitone:AF1Channel:MATChing:LIMit?	<Result>	query only	6.87
CALCulate:ARRay:MULTitone:AF1Channel:MATChing:LIMit?	<Result>	query only	6.88
CONFigure:MULTitone:AF1Channel:RLEVel	0.001 V to 5.000 V	with query	6.76
CONFigure:MULTitone:AF1Channel:RMODe	RLEV | TON1 | ... | TON20	with query	6.77
FETCh:MULTitone:AF1Channel:STATus?	OFF | RUN | STOP | ERR | STEP | RDY, 1 to 10000 | NONE	query only	6.76
CONFigure:MULTitone:AF1Channel:TDEFinition	*<Freq_1>, <Lev_1>,*	with query	6.81

Command	Parameters	Remarks	Page
	<Enable_1>, ... <Freq_20>, <Lev_20>, <Enable_20>		
DEFault:MULTitone:AF1Channel:TDEFinition	ON | OFF	with query	6.83
CONFigure:MULTitone:AF1Channel:TDEFinition:MODE	<Total_Level>	with query	6.82
CONFigure:MULTitone:AF1Channel:TDEFinition:TLEVel	<Total_Level>	with query	6.82
CONFigure:MULTitone:AF1Channel:TDEFinition:TONE<nr>	<Frequency>, <Level>, ON | OFF	with query	6.82
CONFigure:MULTitone:AF1Channel:TONE<nr>:LIMit:LINE :ASYMmetric:LOWer	*<Limit>, <Enable>*	with query	6.80
CONFigure:MULTitone:AF1Channel:TONE<nr>:LIMit:LINE :ASYMmetric:UPPer	*<Limit>, <Enable>*	with query	6.79
CALCulate[:SCALar]:MULTitone:AF1Channel:TONE<nr> :MATChing:LIMit?	<Result>	query only	6.87
READ[:SCALar]:MULTitone:AF1Channel:TONE<nr>?	–100.0 dB to +20.0 dB	query only	6.86
FETCh[:SCALar]:MULTitone:AF1Channel:TONE<nr>?	–100.0 dB to +20.0 dB	query only	6.86
SAMPle[:SCALar]:MULTitone:AF1Channel:TONE<nr>?	–100.0 dB to +20.0 dB	query only	6.86
READ:ARRay:MULTitone:AF1Channel?	–100.0 dB to +20.0 dB	query only	6.86
FETCh:ARRay:MULTitone:AF1Channel?	–100.0 dB to +20.0 dB	query only	6.86
SAMPle:ARRay:MULTitone:AF1Channel?	–100.0 dB to +20.0 dB	query only	6.86
READ:SUBarrays:MULTitone:AF1Channel?	–100.0 dB to +20.0 dB	query only	6.87
FETCh:SUBarrays:MULTitone:AF1Channel?	–100.0 dB to +20.0 dB	query only	6.87
SAMPle:SUBarrays:MULTitone:AF1Channel?	–100.0 dB to +20.0 dB	query only	6.87
INITiate:MULTitone:AF2Channel	–	no query	6.75
ABORt:MULTitone:AF2Channel	–	no query	6.75
STOP:MULTitone:AF2Channel	–	no query	6.75
CONTinue:MULTitone:AF2Channel	–	no query	6.75
CONFigure:SUBarrays:MULTitone:AF2Channel	ALL | ARITHmetical | MINimum | MAXimum | IVAL,<Range>{,<Range>}	with query	6.78
CONFigure:MULTitone:AF2Channel:AFGLead	0 s to 0.1 s	with query	6.77
CONFigure:MULTitone:AF2Channel:CONTrol	AC | DC	with query	6.76
CONFigure:MULTitone:AF2Channel:CONTrol:REPetition	CONTinuous | SINGleshot | 1 to 1000, SONerror | NONE, STEP | NONE	with query	6.77
CONFigure:MULTitone:AF2Channel:EREPorting	SRQ | SOPC | SRSQ | OFF	with query	6.75
DEFault:MULTitone:AF2Channel:FILTer	ON | OFF	with query	6.85
CONFigure:MULTitone:AF2Channel:FILTer:BPASs:ACCoupling	*<Bandpass>*	with query	6.84
CONFigure:MULTitone:AF2Channel:FILTer:BPASs:DCCoupling	*<Bandpass>*	with query	6.84
CONFigure:MULTitone:AF2Channel:FILTer:WEIGhting	*<Weighting>*	with query	6.85
DISPlay:MULTitone:AF2Channel:GRID	ON | OFF	with query	6.76
DEFault:MULTitone:AF2Channel:LIMit:LINE	ON | OFF	with query	6.80
CONFigure:MULTitone:AF2Channel:LIMit:LINE:ASYMmetric :LOWer	*<Limit_1>, <Enable_1>, ... <Limit_20>, <Enable_20>*	with query	6.80
CONFigure:MULTitone:AF2Channel:LIMit:LINE:ASYMmetric :UPPer	*<Limit_1>, <Enable_1>, ... <Limit_20>, <Enable_20>*	with query	6.79
CALCulate[:SCALar]:MULTitone:AF2Channel:MATChing:LIMit?	<Result>	query only	6.87
CALCulate:ARRay:MULTitone:AF2Channel:MATChing:LIMit?	<Result>	query only	6.88
CONFigure:MULTitone:AF2Channel:RLEVel	0.001 V to 5.000 V	with query	6.76
CONFigure:MULTitone:AF2Channel:RMODe	RLEV | TON1 | ... | TON20	with query	6.77
FETCh:MULTitone:AF2Channel:STATus?	OFF | RUN | STOP | ERR |	query only	6.76

Command	**Parameters**	**Remarks**	**Page**
	STEP | RDY, 1 to 10000 | NONE		
CONFigure:MULTitone:AF2Channel:TDEFinition	*<Freq_1>, <Lev_1>, <Enable_1>, ... <Freq_20>, <Lev_20>, <Enable_20>*	with query	6.81
DEFault:MULTitone:AF2Channel:TDEFinition	ON | OFF	with query	6.83
CONFigure:MULTitone:AF2Channel:TDEFinition:MODE	<Total_Level>	with query	6.82
CONFigure:MULTitone:AF2Channel:TDEFinition:TLEVel	<Total_Level>	with query	6.82
CONFigure:MULTitone:AF2Channel:TDEFinition:TONE<nr>	<Frequency>, <Level>, ON | OFF	with query	6.82
CONFigure:MULTitone:AF2Channel:TONE<nr>:LIMit:LINE :ASYMmetric:LOWer	*<Limit>, <Enable>*	with query	6.80
CONFigure:MULTitone:AF2Channel:TONE<nr>:LIMit:LINE :ASYMmetric:UPPer	*<Limit>, <Enable>*	with query	6.79
CALCulate[:SCALar]:MULTitone:AF2Channel:TONE<nr> :MATChing:LIMit?	<Result>	query only	6.87
READ[:SCALar]:MULTitone:AF2Channel:TONE<nr>?	–100.0 dB to +20.0 dB	query only	6.86
FETCh[:SCALar]:MULTitone:AF2Channel:TONE<nr>?	–100.0 dB to +20.0 dB	query only	6.86
SAMPle[:SCALar]:MULTitone:AF2Channel:TONE<nr>?	–100.0 dB to +20.0 dB	query only	6.86
READ:ARRay:MULTitone:AF2Channel?	–100.0 dB to +20.0 dB	query only	6.86
FETCh:ARRay:MULTitone:AF2Channel?	–100.0 dB to +20.0 dB	query only	6.86
SAMPle:ARRay:MULTitone:AF2Channel?	–100.0 dB to +20.0 dB	query only	6.86
READ:SUBarrays:MULTitone:AF2Channel?	–100.0 dB to +20.0 dB	query only	6.87
FETCh:SUBarrays:MULTitone:AF2Channel?	–100.0 dB to +20.0 dB	query only	6.87
SAMPle:SUBarrays:MULTitone:AF2Channel?	–100.0 dB to +20.0 dB	query only	6.87
DEFault:MULTitone:FILTer	ON | OFF	with query	6.85
DEFault:MULTitone:LIMit:LINE	ON | OFF	with query	6.81
DEFault:MULTitone:TDEFinition	ON | OFF	with query	6.83
Subsystem OPTions (options)			
SYSTem:OPTions:INFO:CURRent?		query only	6.65
Partial reset			
SYSTem:RESet:CURRent		no query	6.66

Alphabetical Command Lists

Table 6-4 Alphabetical list of remote-control commands: Base system

Command (Base System, alphabetical)	Page
*GTL	6.15
*LLO	6.17
*SEC	6.11
[SENSe:]SYNChronize:FREQuency:REFerence:LOCKed?	6.23
CONFigure:SYNChronize:FREQuency:REFerence	6.23
CONFigure:SYNChronize:FREQuency:REFerence:MODE	6.23
MMEMory:CDIRectory	6.20
MMEMory:COMMent	6.19
MMEMory:COPY	6.20
MMEMory:DATA?	6.22
MMEMory:DELete	6.20
MMEMory:DIRectory[:CURRent]?	6.19
MMEMory:INFO?	6.18
MMEMory:MKDir	6.20
MMEMory:MOVE	6.21
MMEMory:MSIS	6.19
MMEMory:RECall:CURRent	6.23
MMEMory:RECall[:ALL]	6.22
MMEMory:REName	6.21
MMEMory:RMDir	6.20
MMEMory:SAVE:CURRent	6.22
MMEMory:SAVE[:ALL]	6.22
MMEMory:SCAN?	6.21
STATus:OPERation:CMU:ALL	6.7
STATus:OPERation:CMU:CLEar	6.7
STATus:OPERation:CMU:SUM<nr>:CMU<nr_event>:ENABle	6.7
STATus:OPERation:CMU:SUM<nr>:CMU<nr_event>[EVENt]?	6.6
STATus:OPERation:CMU:SUM<nr>:ENABle	6.6
STATus:OPERation:CMU:SUM<nr>[EVENt]?	6.6
STATus:OPERation:ENABle	6.6
STATus:OPERation:EVENt:SADDress?	6.9
STATus:OPERation:SYMBolic:ENABle	6.9
STATus:OPERation:SYMBolic[:EVENt]?	6.9
STATus:OPERation[EVENt]?	6.6
STATus:PRESet	6.7
STATus:QUEStionable:ENABle	6.7
STATus:QUEStionable[EVENt]?	6.7
SYSTem:COMMunicate:GPIB[:SELF]:ADDRess	6.11
SYSTem:COMMunicate:SERial<1|2>:APPLication	6.11
SYSTem:COMMunicate:SERial<1|2>:TRANsmit:PACE	6.12
SYSTem:COMMunicate:SERial<1|2>[:RECeive]:BAUD	6.11
SYSTem:COMMunicate:SERial<1|2>[:RECeive]:BITs	6.12
SYSTem:COMMunicate:SERial<1|2>[:RECeive]:PARity[:TYPE]	6.12
SYSTem:COMMunicate:SERial<1|2>[:RECeive]:STOP	6.12
SYSTem:ERRor?	6.5
SYSTem:GTRMode:COMPatible	6.15
SYSTem:MISC:KBEep	6.14
SYSTem:MISC:KEYBoard	6.14
SYSTem:MQUeue[:COMPlete]:ITEM?	6.16
SYSTem:MQUeue[:COMPlete][:LIST]?	6.15
SYSTem:NONVolatile:DISable	6.5
SYSTem:OPTions:INFO?	6.12
SYSTem:OPTions?	6.13

Command (Base System, alphabetical)	Page
SYSTem:PRESet[:ALL]	6.16
SYSTem:REMote:ADDRess:PRIMary	6.10
SYSTem:REMote:ADDRess:SECondary	6.10
SYSTem:RESet:CURRent	6.16
SYSTem:RESet[:ALL]	6.16
SYSTem:TIMe:DATe	6.14
SYSTem:TIMe:TZONe	6.13
SYSTem:TIMe[:TIMe]	6.13
SYSTem:VERSion?	6.5
TRACe:REMote:MODE:DISPlay	6.17
TRACe:REMote:MODE:ERRor	6.17
TRACe:REMote:MODE:FILE	6.17
TRACe:REMote:MODE:OUTLines	6.18
TRACe:REMote:MODE:SQR	6.17

Table 6-5 Alphabetical list of remote-control commands: RF

Command (RF, alphabetical)	Page
[SENSe:]CORRection:LOSS:INPut<nr>[:MAGNitude]	6.39
[SENSe:]CORRection:LOSS:OUTPut<nr>:AUXTx[:MAGNitude]	6.40
[SENSe:]CORRection:LOSS:OUTPut<nr>[:TX][:MAGNitude]	6.40
[SENSe:]LEVel:ATTenuation	6.27
[SENSe:]LEVel:DEFault	6.27
[SENSe:]LEVel:MAXimum	6.26
[SENSe:]LEVel:MODE	6.27
[SENSe:]LEVel:REFerence	6.27
[SENSe:]NPOWer:BWIDth[:RESolution]	6.61
[SENSe:]POWer:FREQuency:BANDwidth[:RESolution]	6.46
[SENSe:]POWer:FREQuency:BWIDth[:RESolution]	6.46
[SENSe:]POWer:FREQuency:CENTer	6.46
[SENSe:]POWer:LEVel:RANGe	6.46
[SENSe:]POWer:TIME:DELay	6.47
[SENSe:]POWer:TIME:SPAN	6.47
[SENSe:]RFANalyzer:BANDwidth[:RESolution]	6.30
[SENSe:]RFANalyzer:BWIDth[:RESolution]	6.30
[SENSe:]RFANalyzer:FREQuency	6.30
[SENSe:]SPECtrum:DETector	6.52
[SENSe:]SPECtrum:FREQuency:BANDwidth[:RESolution]	6.53
[SENSe:]SPECtrum:FREQuency:BWIDth[:RESolution]	6.53
[SENSe:]SPECtrum:FREQuency:CENTer	6.53
[SENSe:]SPECtrum:FREQuency:SPAN	6.53
[SENSe:]SPECtrum:FREQuency:STARt	6.53
[SENSe:]SPECtrum:FREQuency:STOP	6.53
[SENSe:]SPECtrum:LEVel:RANGe	6.54
ABORt:NPOWer	6.59
ABORt:POWer	6.44
ABORt:RFANalyzer	6.30
ABORt:RFGenerator	6.33
ABORt:SPECtrum	6.51
ABORt:WPOWer	6.57
CONFigure:IQIF:RXPath	6.42
CONFigure:IQIF:RXTXcombined	6.42
CONFigure:IQIF:TXPath	6.42
CONFigure:NPOWer:CONTrol	6.60
CONFigure:NPOWer:CONTrol:REPetition	6.61

Command (RF, alphabetical)	Page
CONFigure:NPOWer:CONTrol:STATistics	*6.61*
CONFigure:NPOWer:EREPorting	*6.59*
CONFigure:POWer:CONTrol	*6.45*
CONFigure:POWer:CONTrol:REPetition	*6.45*
CONFigure:POWer:EREPorting	*6.44*
CONFigure:RFANalyzer:CONTrol:REPetition	*6.32*
CONFigure:RFANalyzer:EREPorting	*6.31*
CONFigure:RFANalyzer:POWer:RTIMe	*6.32*
CONFigure:RFGenerator:APPLication	*6.33*
CONFigure:SPECtrum:CONTrol	*6.52*
CONFigure:SPECtrum:CONTrol:REPetition	*6.53*
CONFigure:SPECtrum:EREPorting	*6.51*
CONFigure:SUBarrays:POWer	*6.48*
CONFigure:SUBarrays:SPECtrum	*6.54*
CONFigure:WPOWer:CONTrol:REPetition	*6.58*
CONFigure:WPOWer:EREPorting	*6.57*
CONTinue:NPOWer	*6.59*
CONTinue:POWer	*6.44*
CONTinue:RFANalyzer	*6.30*
CONTinue:SPECtrum	*6.51*
CONTinue:WPOWer	*6.57*
DEFault:RFGenerator	*6.33*
DEFault:RFGenerator:AUXTx	*6.38*
DEFault:RFGenerator:TX	*6.33*
FETCh:ARRay:POWer:AVERage?	*6.49*
FETCh:ARRay:POWer:MAXimum?	*6.49*
FETCh:ARRay:POWer:MINimum?	*6.49*
FETCh:ARRay:POWer:MINimum?	*6.49*
FETCh:ARRay:POWer[:CURRent]?	*6.49*
FETCh:ARRay:SPECtrum:AVERage?	*6.55*
FETCh:ARRay:SPECtrum:MAXimum?	*6.55*
FETCh:ARRay:SPECtrum:MINimum?	*6.55*
FETCh:ARRay:SPECtrum:MINimum?	*6.55*
FETCh:ARRay:SPECtrum[:CURRent]?	*6.55*
FETCh:NPOWer:STATus?	*6.60*
FETCh:POWer:STATus?	*6.44*
FETCh:RFANalyzer:STATus?	*6.31*
FETCh:RFGenerator:STATus?	*6.34*
FETCh:SPECtrum:STATus?	*6.51*
FETCh:SUBarrays:POWer:AVERage?	*6.50*
FETCh:SUBarrays:POWer:MAXimum?	*6.50*
FETCh:SUBarrays:POWer:MINimum?	*6.50*
FETCh:SUBarrays:POWer:MINimum?	*6.50*
FETCh:SUBarrays:POWer[:CURRent]?	*6.50*
FETCh:SUBarrays:SPECtrum:AVERage?	*6.56*
FETCh:SUBarrays:SPECtrum:MAXimum?	*6.56*
FETCh:SUBarrays:SPECtrum:MINimum?	*6.56*
FETCh:SUBarrays:SPECtrum:MINimum?	*6.56*
FETCh:SUBarrays:SPECtrum[:CURRent]?	*6.56*
FETCh:WPOWer:STATus?	*6.57*
FETCh[:SCALar]:NPOWer?	*6.62*
FETCh[:SCALar]:RFANalyzer:POWer?	*6.32*
FETCh[:SCALar]:WPOWer?	*6.58*
INITiate:NPOWer	*6.59*
INITiate:POWer	*6.44*
INITiate:RFANalyzer	*6.30*
INITiate:RFGenerator	*6.33*
INITiate:SPECtrum	*6.51*
INITiate:WPOWer	*6.57*

Command (RF, alphabetical) **Page**

INPut[:STATe] 6.39
IQIF:DEFault 6.43
MMEMory:RECall:CURRent 6.26
MMEMory:SAVE:CURRent 6.25
OUTPut:AUXTx[:STATe] 6.40
OUTPut[:TX][:STATe] 6.39
READ:ARRay:POWer:AVERage? 6.49
READ:ARRay:POWer:MAXimum? 6.49
READ:ARRay:POWer:MINimum? 6.49
READ:ARRay:POWer:MINimum? 6.49
READ:ARRay:POWer[:CURRent]? 6.49
READ:ARRay:SPECtrum:AVERage? 6.55
READ:ARRay:SPECtrum:MAXimum? 6.55
READ:ARRay:SPECtrum:MINimum? 6.55
READ:ARRay:SPECtrum:MINimum? 6.55
READ:ARRay:SPECtrum[:CURRent]? 6.55
READ:SUBarrays:POWer:AVERage? 6.50
READ:SUBarrays:POWer:MAXimum? 6.50
READ:SUBarrays:POWer:MINimum? 6.50
READ:SUBarrays:POWer:MINimum? 6.50
READ:SUBarrays:POWer[:CURRent]? 6.50
READ:SUBarrays:SPECtrum:AVERage? 6.56
READ:SUBarrays:SPECtrum:MAXimum? 6.56
READ:SUBarrays:SPECtrum:MINimum? 6.56
READ:SUBarrays:SPECtrum:MINimum? 6.56
READ:SUBarrays:SPECtrum[:CURRent]? 6.56
READ[:SCALar]:NPOWer? 6.62
READ[:SCALar]:RFANalyzer:POWer? 6.32
READ[:SCALar]:WPOWer? 6.58
SAMPle:ARRay:POWer:AVERage? 6.49
SAMPle:ARRay:POWer:MAXimum? 6.49
SAMPle:ARRay:POWer:MINimum? 6.49
SAMPle:ARRay:POWer[:CURRent]? 6.49
SAMPle:ARRay:SPECtrum:AVERage? 6.55
SAMPle:ARRay:SPECtrum:MAXimum? 6.55
SAMPle:ARRay:SPECtrum:MINimum? 6.55
SAMPle:ARRay:SPECtrum[:CURRent]? 6.55
SAMPle:SUBarrays:POWer:AVERage? 6.50
SAMPle:SUBarrays:POWer:MAXimum? 6.50
SAMPle:SUBarrays:POWer:MINimum? 6.50
SAMPle:SUBarrays:POWer[:CURRent]? 6.50
SAMPle:SUBarrays:SPECtrum:AVERage? 6.56
SAMPle:SUBarrays:SPECtrum:MAXimum? 6.56
SAMPle:SUBarrays:SPECtrum:MINimum? 6.56
SAMPle:SUBarrays:SPECtrum[:CURRent]? 6.56
SAMPle[:SCALar]:NPOWer? 6.62
SAMPle[:SCALar]:RFANalyzer:POWer? 6.32
SAMPle[:SCALar]:WPOWer? 6.58
SOURce:CORRection:LOSS:INPut<nr>[:MAGNitude] 6.39
SOURce:CORRection:LOSS:OUTPut<nr>:AUXTx[:MAGNitude] 6.40
SOURce:CORRection:LOSS:OUTPut<nr>[:TX][:MAGNitude] 6.40
SOURce:DM:CLOCk:FREQuency 6.41
SOURce:DM:CLOCk:STATe 6.40
SOURce:RFGenerator:AUXTx:FREQuency 6.38
SOURce:RFGenerator:AUXTx:LEVel 6.38
SOURce:RFGenerator:BANDwidth 6.37
SOURce:RFGenerator:BWIDth 6.37
SOURce:RFGenerator:FHOPping:FREQuency 6.36
SOURce:RFGenerator:FHOPping:FREQuency:MODE 6.36

Command (RF, alphabetical)	**Page**
SOURce:RFGenerator:FHOPping:STATe	*6.36*
SOURce:RFGenerator:MODulation	*6.35*
SOURce:RFGenerator:MODulation:SSB:FREQuency	*6.35*
SOURce:RFGenerator:MODulation[:AM]:INDex	*6.35*
SOURce:RFGenerator:PULSe:STATe	*6.37*
SOURce:RFGenerator[:TX]:FREQuency	*6.34*
SOURce:RFGenerator[:TX]:LEVel	*6.34*
STOP:NPOWer	*6.59*
STOP:POWer	*6.44*
STOP:RFANalyzer	*6.30*
STOP:SPECtrum	*6.51*
STOP:WPOWer	*6.57*
SYSTem:OPTions:INFO:CURRent?	*6.25*
SYSTem:RESet:CURRent	*6.26*
TRIGger[:SEQuence]:DEFault	*6.29*
TRIGger[:SEQuence]:SLOPe	*6.28*
TRIGger[:SEQuence]:SOURce	*6.28*
TRIGger[:SEQuence]:SOURce:EXTernal	*6.29*
TRIGger[:SEQuence]:THReshold:IFPower	*6.28*
TRIGger[:SEQuence]:THReshold:RFPower	*6.28*

Table 6-6 Alphabetical list of remote-control commands: Audio

Command (Audio, alphabetical)	**Page**
[SENSe:]AFLevel:DEFault	*6.67*
[SENSe:]AFLevel:SECondary:MAXimum	*6.67*
[SENSe:]AFLevel:SECondary:MODE	*6.66*
[SENSe:]AFLevel[:PRIMary]:MAXimum	*6.67*
[SENSe:]AFLevel[:PRIMary]:MODE	*6.66*
ABORt:AFANalyzer:SECondary	*6.68*
ABORt:AFANalyzer[:PRIMary]	*6.68*
ABORt:AFGenerator:SECondary	*6.73*
ABORt:AFGenerator[:PRIMary]	*6.73*
ABORt:MULTitone:AF1Channel	*6.75*
ABORt:MULTitone:AF2Channel	*6.75*
CALCulate:ARRay:MULTitone:AF1Channel:MATChing:LIMit?	*6.88*
CALCulate:ARRay:MULTitone:AF2Channel:MATChing:LIMit?	*6.88*
CALCulate[:SCALar]:MULTitone:AF1Channel:MATChing:LIMit?	*6.87*
CALCulate[:SCALar]:MULTitone:AF1Channel:TONE<nr>:MATChing:LIMit?	*6.87*
CALCulate[:SCALar]:MULTitone:AF2Channel:MATChing:LIMit?	*6.87*
CALCulate[:SCALar]:MULTitone:AF2Channel:TONE<nr>:MATChing:LIMit?	*6.87*
CONFigure:AFANalyzer:SECondary:CONTrol:COUPling	*6.70*
CONFigure:AFANalyzer:SECondary:CONTrol:DISTortion[:FREQuency]	*6.70*
CONFigure:AFANalyzer:SECondary:CONTrol:REPetition	*6.69*
CONFigure:AFANalyzer:SECondary:EREPorting	*6.68*
CONFigure:AFANalyzer:SECondary:FILTer:BPASs:ACCoupling	*6.71*
CONFigure:AFANalyzer:SECondary:FILTer:BPASs:DCCoupling	*6.72*
CONFigure:AFANalyzer:SECondary:FILTer:VBPass:BWIDth	*6.71*
CONFigure:AFANalyzer:SECondary:FILTer:VBPass:CFRequency	*6.70*
CONFigure:AFANalyzer:SECondary:FILTer:WEIGhting	*6.71*
CONFigure:AFANalyzer:SECondary:MTReduce	*6.69*
CONFigure:AFANalyzer[:PRIMary]:CONTrol:COUPling	*6.70*
CONFigure:AFANalyzer[:PRIMary]:CONTrol:DISTortion[:FREQuency]	*6.70*
CONFigure:AFANalyzer[:PRIMary]:CONTrol:REPetition	*6.69*
CONFigure:AFANalyzer[:PRIMary]:EREPorting	*6.68*

Command (Audio, alphabetical)	Page
CONFigure:AFANalyzer[:PRIMary]:FILTer:BPASs:ACCoupling	6.71
CONFigure:AFANalyzer[:PRIMary]:FILTer:BPASs:DCCoupling	6.72
CONFigure:AFANalyzer[:PRIMary]:FILTer:VBPass:BWIDth	6.71
CONFigure:AFANalyzer[:PRIMary]:FILTer:VBPass:CFRequency	6.70
CONFigure:AFANalyzer[:PRIMary]:FILTer:WEIGhting	6.71
CONFigure:AFANalyzer[:PRIMary]:MTReduce	6.69
CONFigure:MULTitone:AF1Channel:AFGLead	6.77
CONFigure:MULTitone:AF1Channel:CONTrol	6.76
CONFigure:MULTitone:AF1Channel:CONTrol:REPetition	6.77
CONFigure:MULTitone:AF1Channel:EREPorting	6.75
CONFigure:MULTitone:AF1Channel:FILTer:BPASs:ACCoupling	6.84
CONFigure:MULTitone:AF1Channel:FILTer:BPASs:DCCoupling	6.84
CONFigure:MULTitone:AF1Channel:FILTer:WEIGhting	6.85
CONFigure:MULTitone:AF1Channel:LIMit:LINE:ASYMmetric:LOWer	6.80
CONFigure:MULTitone:AF1Channel:LIMit:LINE:ASYMmetric:UPPer	6.79
CONFigure:MULTitone:AF1Channel:RLEVel	6.76
CONFigure:MULTitone:AF1Channel:RMODe	6.77
CONFigure:MULTitone:AF1Channel:TDEFinition	6.81
CONFigure:MULTitone:AF1Channel:TDEFinition:MODE	6.82
CONFigure:MULTitone:AF1Channel:TDEFinition:TLEVel	6.82
CONFigure:MULTitone:AF1Channel:TDEFinition:TONE<nr>	6.82
CONFigure:MULTitone:AF1Channel:TONE<nr>:LIMit:LINE:ASYMmetric:LOWer	6.80
CONFigure:MULTitone:AF1Channel:TONE<nr>:LIMit:LINE:ASYMmetric:UPPer	6.79
CONFigure:MULTitone:AF2Channel:AFGLead	6.77
CONFigure:MULTitone:AF2Channel:CONTrol	6.76
CONFigure:MULTitone:AF2Channel:CONTrol:REPetition	6.77
CONFigure:MULTitone:AF2Channel:EREPorting	6.75
CONFigure:MULTitone:AF2Channel:FILTer:BPASs:ACCoupling	6.84
CONFigure:MULTitone:AF2Channel:FILTer:BPASs:DCCoupling	6.84
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SAMPle[:SCALar]:AFANalyzer[:PRIMary]?	6.73
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7 Remote Control – Program Examples

The program examples in this chapter are intended to give a short introduction to GPIB bus programming of the CMU illustrating some of the concepts discussed in Chapter 5. For examples involving optional function groups (network tests) refer to the relevant manuals, e.g. *CMU-K21/-K22/-K23.*

Secondary Address Handling

The following example explains how to handle primary and secondary addressing and how to perform a simple measurement with the CMU. In the example, remote control via the *National Instruments* GPIB bus driver (NI-488.2) and the programming language C is used. Once the addresses are assigned, the same commands can be used in different function groups.

```
// Include header files
#include <string.h>

/*  NI488.2 header file */
#include <decl.h>

// GPIB board index
#define BdIndx                      0

// Primary address
#define pad                         20

// Secondary address for Base Definition (National Instruments specific)
#define sad_BASE                    96

// Secondary  Address for function groups definition
// (conforming to IEEE488.2)
#define _RF_NSig                     1
#define _GSM900MS_Sig                2
#define _GSM900MS_NSig               3
#define _GSM1800MS_Sig               4

#define sad_RF_NSig               sad_BASE + _RF_NSig
#define sad_GSM900MS_Sig          sad_BASE + _GSM900MS_Sig
#define sad_GSM900MS_NSig         sad_BASE + _GSM900MS_NSig
#define sad_GSM1800MS_Sig         sad_BASE + _GSM1800MS_Sig

// Timeout
#define tmo                       (int) 10

// EOT
#define eot                       (int) 1

// EOS
#define eos                       (int) 0

// Command definition for secondary address mapping
```

```
#define Map_Command                "SYST:REM:ADDR:SEC %d,\"%s\""

#define IdStr_RF_NSig                   "RF_NSig"
#define IdStr_GSM900MS_Sig         "GSM900MS_Sig"
#define IdStr_GSM900MS_NSig        "GSM900MS_NSig"
#define IdStr_GSM1800MS_Sig       "GSM1800MS_Sig "

// Variable declarations
int h_BASE;
int h_RF_NSig;
int h_GSM900MS_Sig;
int h_GSM900MS_NSig;
int h_GSM1800MS_Sig;

char InBuffer [100];
char Command [100];

// Request of the basesystem handle
h_BASE = ibdev (BdIndx, pad, sad_BASE, tmo, eot, eos);

// Mapping of secondary addresses for the function groups
sprintf (Command, Map_Command, _RF_NSig,IdStr_RF_NSig);
ibwrt(h_BASE, Command, strlen(Command));
sprintf (Command, Map_Command, _GSM900MS_Sig, IdStr_GSM900MS_Sig);
ibwrt(h_BASE,Command, strlen(Command));
sprintf (Command, "Map_Command _GSM900MS_NSig, IdStr_GSM900MS_NSig);
ibwrt(h_BASE,Command, strlen(Command));
sprintf (Command, "Map_Command _GSM1800MS_Sig, IdStr_GSM1800MS_Sig);
ibwrt(h_BASE,Command, strlen(Command));

// Request of function group handles
h_RF_NSig = ibdev (BdIndx, pad, sad_RF_NSig, tmo, eot, eos);
h_GSM900MS_Sig = ibdev (BdIndx, pad, sad_GSM900MS_Sig, tmo, eot, eos);
h_GSM900MS_NSig = ibdev (BdIndx, pad, sad_GSM900MS_NSig, tmo, eot, eos);
h_GSM1800MS_Sig = ibdev (BdIndx, pad, sad_GSM1800MS_Sig, tmo, eot, eos);
```

Simple Measurements

The following measurement examples require option CMU-K21/-K22/-K23 to be installed – see separate operating manual for GSM900/1800/1900 mobile tests.

```
// Example for a GSM900 mobile with power and
// modulation measurement at PCL 5 and PCL 10


ibwrt(h_GSM900MS_Sig, "PROC:SIGN:MS:PCL 5", 18);
ibwrt(h_GSM900MS_Sig, "READ:SCAL:POW:RES?", 18);
ibrd (h_GSM900MS_Sig, InBuffer, sizeof (InBuffer));
...
ibwrt(h_GSM900MS_Sig, "READ:SCAL:MOD:RES?",18);
ibrd (h_GSM900MS_Sig, InBuffer, sizeof (InBuffer));
...
ibwrt(h_GSM900MS_Sig, "PROC:SIGN:MS:PCL 10",19);
ibwrt(h_GSM900MS_Sig, "READ:SCAL:POW:RES?",18);
ibrd (h_GSM900MS_Sig, InBuffer,sizeof (InBuffer));
...
ibwrt(h_GSM900MS_Sig, "READ:SCAL:MOD:RES?",18);
ibrd (h_GSM900MS_Sig, InBuffer,sizeof (InBuffer));
...

// Example for a GSM1800 mobile with a power and
// modulation measurement at PCL 5 and PCL 10


ibwrt(h_GSM1800MS_Sig, "PROC:SIGN:MS:PCL 5",18);
ibwrt(h_GSM1800MS_Sig, "READ:SCAL:POW:RES?",18);
ibrd (h_GSM1800MS_Sig, InBuffer,sizeof (InBuffer));
...
ibwrt(h_GSM1800MS_Sig, "READ:SCAL:MOD:RES?",18);
ibrd (h_GSM1800MS_Sig, InBuffer,sizeof (InBuffer));
...
ibwrt(h_GSM1800MS_Sig, "PROC:SIGN:MS:PCL 10",19);
ibwrt(h_GSM1800MS_Sig, "READ:SCAL:POW:RES?",18);
ibrd (h_GSM1800MS_Sig, InBuffer,sizeof (InBuffer));
...
ibwrt(h_GSM1800MS_Sig, "READ:SCAL:MOD:RES?",18);
ibrd (h_GSM1800MS_Sig, InBuffer,sizeof (InBuffer));
```

Measuring the I/Q Spectrum of a Mobile

GSM uses the GMSK modulation scheme with a symbol rate of 270.833 kBit/s and four different phases that can be occupied during one symbol interval. If a constant series of zeros or ones is transmitted, the rotation of the I/Q vector causes a side band at 270.833/4 Hz = 667.70825 Hz from the carrier. Compared to the side band, the original carrier frequency is suppressed by –30 dB to –40 dB. The following example program measures the carrier signal, the upper and the lower side band using the *RF Spectrum* and the *RF Power vs Time* measurement groups. No additional options are needed.

To keep the syntax as short and simple as possible, the programs were written with the aid of *Winbatch*, a batch job tool organizing and simplifying the transfer of commands and data between the controller and the instrument.

Winbatch uses device names such as *CMUBASE, CMUGSMNS, CMUGSMSIG* which are previously defined and assigned to the primary address, secondary address, and some general device settings. With these device names, a complete command line reads:

`CMUBASE: <CMU_Command>`

where `<CMU_Command>` may be any of the commands (setting commands or queries) specified within the function group and mode identified by the device name *CMUBASE.* Program sequences consisting of commands that are defined in several function groups and modes can be re-used with an exchanged device name.

In addition to these data transfer commands, *Winbatch* provides *WHILE, GOTO*, and *IF* statements to express conditions and define loops. Program examples utilizing these statements can be found in the manuals for network tests, e.g. *GSM900/1800/1900-MS.* For the following example, configure your *Winbatch* settings such that *CMUBASE* is the device name for the CMU *BASE* system and *CMURF* denotes function group *RF (Non Signalling).*

```
ECHO ON

FPRINT ...............................................................................
FPRINT    INITIALISATION ROUTINE:
FPRINT    ASK FOR THE IDENTIFIER OF THE CMU, RESET THE INSTRUMENT,
FPRINT    DEFINE THE SECONDARY ADDRESSES FOR ALL AVAILABLE FUNCTION GROUPS
FPRINT ...............................................................................

CMUBASE: *IDN?                            Identification query
CMUBASE: *RST;*OPC?                       Reset the instrument; prevent the following command
                                                to be executed before *RST is complete
CMUBASE: *CLS                             Clear output buffer, set status byte
CMUBASE: SYST:REM:ADDR:SEC 1,"RF_NSig"    Define function group RF Non Signalling, the CMU Base
                                                system is always assigned secondary address 0

FPRINT ...............................................................................
FPRINT   CONNECTORS
FPRINT ...............................................................................

CMURF: INP:STAT RF2                       Define input connector RF2
CMURF: OUTP:STAT RF2                      Define output connector RF2

FPRINT ...............................................................................
FPRINT   RF GENERATOR SETTINGS
FPRINT ...............................................................................

CMURF: SOUR:RFG:FREQ 900 MHZ              Set RF generator frequency
CMURF: SOUR:RFG:MOD SSB                   Switch on frequency offset (single side band modulation)
CMURF: SOUR:RFG:MOD:SSB:FREQ 67.7 KHZ     Set offset frequency
CMURF: INIT:RFG;*OPC?                     Switch on RF generator


FPRINT ...............................................................................
FPRINT   SPECTRUM ANALYZER SETTINGS
FPRINT   REFERENCE LEVEL ONLY EXISTS IN THE MANUAL MODE (Defines display area)
FPRINT ...............................................................................

CMURF: SENS:SPEC:FREQ:CENT 900 MHZ        Set center frequency for spectrum measurement
CMURF: SENS:SPEC:FREQ:SPAN 500 KHZ        Set frequency span
CMURF: SENS:SPEC:FREQ:BAND 20 KHZ         Set resolution bandwidth of the spectrum analyzer
CMURF: CONF:SPEC:CONT:REP SING,NONE,NONE  Single shot measurement, no stop on error

FPRINT ...............................................................................
FPRINT   SPECTRUM MEASUREMENT AT 900 MHZ + OFFSET 67.7 KHZ, 1 POINT
FPRINT ...............................................................................

CMURF: CONF:ARR:SPEC:RANG 900.0677 MHZ,1  Select single measurement point at 900.0677 MHz
CMURF: READ:ARR:SPEC?                     Start single shot spectrum measurement, wait until it is
                                                terminated, and return result (1 value)

FPRINT ...............................................................................
FPRINT   HAVE A LOOK AT SPECIFIC OFFSETS (SUPPRESSED CARRIER AT 900 MHZ)
FPRINT ...............................................................................

CMURF: CONF:ARR:SPEC:RANG 900 MHZ,1       Select single measurement point
CMURF: READ:ARR:SPEC?                     Start single shot spectrum measurement, wait until it is
                                                terminated, and return result (1 value)

FPRINT ...............................................................................
FPRINT   HAVE A LOOK AT SPECIFIC OFFSETS (THE OTHER SIDEBAND 900 MHZ - 67.7 KHZ)
FPRINT ...............................................................................

CMURF: CONF:ARR:SPEC:RANG 899.9323 MHZ,1  Select single measurement point
CMURF: READ:ARR:SPEC?                     Start single shot spectrum measurement, wait until it is
                                                terminated, and return result (1 value)

FPRINT ...............................................................................
```

```
CMURF: ABOR:SPEC                          Abort spectrum measurement and free resources

FPRINT .............................................................................
FPRINT   PRODUCE A RAMPED SIGNAL
FPRINT .............................................................................

CMURF: SOUR:RFG:PULS:STAT ON;*OPC?        Select pulsed signal (as opposed to CW)

FPRINT .............................................................................
FPRINT   CONFIGURE THE POWER/T MEASUREMENT
FPRINT .............................................................................

CMURF: SENS:POW:FREQ:CENT 900.0677 MHZ    Set center frequency for power vs. time measurement
CMURF: SENS:POW:FREQ:BAND 20 KHZ          Set resolution bandwidth of the RF analyzer
CMURF: SENS:POW:TIME:SPAN 1MS             Set evaluation time of power measurement
CMURF: TRIG:SOUR IFP                      Trigger meas. by IF signal level (recommended)
CMURF: LEV:MAX -10                        Set expected maximum input level

CMURF: CONF:ARR:POW:RANG 3E-4,1           Select single measurement point at 0.3 ms
CMURF: CONF:POW:CONT:REP SING,NONE,NONE   Single shot measurement, no stop on error
CMURF: SYST:ERR?                          Read error queue
CMURF: INIT:POW                           Initiate power vs. time measurement

CMURF: READ:ARR:POW?                      Start single shot measurement, wait until it is
                                                terminated, and return result (1 value)

FPRINT .............................................................................
FPRINT   HAVE A LOOK AT SPECIFIC OFFSETS (SUPPRESSED CARRIER AT 900 MHZ)
FPRINT .............................................................................

CMURF: SENS:POW:FREQ:CENT 900 MHZ         Set center frequency for power vs. time measurement
CMURF: READ:ARR:POW?                      Start single shot measurement, wait until it is
                                                terminated, and return result (1 value)

FPRINT .............................................................................
FPRINT   HAVE A LOOK AT SPECIFIC OFFSETS (THE OTHER SIDEBAND 900 MHZ - 67.7 KHZ)
FPRINT .............................................................................

CMURF: SENS:POW:FREQ:CENT 899.9323 MHZ    Set center frequency for power vs. time measurement
CMURF: READ:ARR:POW?                      Start single shot measurement, wait until it is
                                                terminated, and return result (1 value)

SETLOCAL                                  Quit remote control mode
```

Symbolic Status Event Register Evaluation

The following example program shows how the EVENt part of the `STATus:OPERation` registers can be read using the commands for symbolic status register evaluation typed in boldface. The program provokes and evaluates the event *Reference Frequency Not Locked (RFNL)* which is reported by bit no. 6 of the `STATus:OPERation:CMU:SUM1:CMU1` sub-register assigned to the CMU base system (see sections *Symbolic Status Event Register Evaluation* and *STATus:OPERation Register* in chapter 5).

```
CMUBASE: *RST;*OPC?                       Reset the instrument; prevent the following command
                                                from being executed before *RST is complete
CMUBASE: *CLS                             Clear output buffer, set status byte
CMUBASE: CONF:SYNC:FREQ:REF:MODE?
CMUBASE: CONF:SYNC:FREQ:REF:MODE EXT      Provoke event -> Reference Frequency Not Locked
                                                (external reference frequency selected but no
                                                external input signal available)
```

```
CMUBASE:  TRACE:REMOTE:MODE:FILE ON          Remote trace to file
CMUBASE:  TRACE:REMOTE:MODE:DISPLAY ON       Remote trace display ON
CMUBASE:  TRACE:REMOTE:MODE:SRQ ON           Display SRQ event on remote trace window
CMUBASE:  STATUS:PRESET                      Reset status register system
CMUBASE:  *STB?                              Check status byte
CMUBASE:  *SRE?                              Check service request enable
CMUBASE:  *SRE 128                           Service request for OPERATION register
CMUBASE:  *STB?                              Check status byte
CMUBASE:  STAT:OPER:SYMB:ENAB?               Check symbolic status register enable --> NONE

CMUBASE:  STAT:OPER:SYMB:ENAB RFNL           Enable symbolic status register evaluation
                                                (event Reference Frequency Not Locked = RFNL )

[1_LOOP]
if CMUBASE: *STB? <> 0 goto read_event       Read STB Bit 7 is set (that is SRQ)
PAUSE 2000                                   Wait 2 seconds
goto 1_LOOP
[read_event]

CMUBASE:  STAT:OPER:EVENT:SADD?              Eval. which SecAddr causes the Event? --> CMUBASE
CMUBASE:  STAT:OPER:SYMB?                    Eval. which bit (event) causes SRQ --> RFNL
CMUBASE:  *STB?
CMUBASE:  *STB?
goto 1_LOOP
```

Tips and Tricks for CMU Programming

The following section is intended to give hints for efficient programming and to point out frequent mistakes that may impair the system performance.

1. Avoid Frequent DLL Swapping

Many CMU function groups use the same commands enabling program parts to be reused in different contexts. As a consequence, commands may be repeated several times within a program that addresses several function groups. The CMU is designed for multi-mode operation, however, changing from one function group to another generally absorbs system capacity for loading new software modules. It is therefore advisable to group the commands so that the number of function group swaps is minimized.

Instead of

```
GSM900MS_Sig: <Setting_A>
GSM400MS_Sig: <Setting_A>
...
GSM900MS_Sig: <Setting_B>
GSM400MS_Sig: <Setting_B>
```

write

```
GSM900MS_Sig: <Setting_A>
GSM900MS_Sig: <Setting_B>
...
GSM400MS_Sig: <Setting_A>
GSM400MS_Sig: <Setting_B>
```

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8 Maintenance and Interfaces

The following chapter contains information on the maintenance of the CMU.

Please follow the instructions in the service manual when exchanging modules or ordering spares. The order no. for spare parts can be found in the service manual.

The address of our support center and a list of all Rohde & Schwarz service centers can be found at the beginning of this manual.

The service manual includes further information particularly on troubleshooting, repair, exchange of modules (including battery exchange, adjustment of the OCXO oscillator) and calibration.

Maintenance

The CMU does not require any special maintenance. Remove any contamination on the instrument by means of a soft cloth. Make sure that the air vents are not obstructed.

Cleaning the Outside

The outside of the instrument is suitably cleaned using a soft, line-free dust cloth.

⚠ ***Caution!***
Never use solvents such as thinners, acetone and similar things, as they may damage the front panel labeling or plastic parts.

Storing and Packing

The CMU can be stored at the temperature range quoted in the data sheet. When stored for an extended period of time the instrument should be protected against dust.

The original packing should be used, particularly the protective covers at the front and rear, when the instrument is to be transported or dispatched. If the original packing is no longer available, use a sturdy cardboard box of suitable size and carefully wrap the instrument to protect it against mechanical damage.

Hardware Interfaces

GPIB Bus Interface

The standard instrument is equipped with an GPIB bus (IEC/IEEE-bus) connection. The interface connector labeled *IEEE 488 / IEC 625* is located on the rear panel of the instrument. A controller for remote control can be connected via the GPIB bus interface using a shielded cable.

Characteristics of the Interface

- 8-bit parallel data transfer
- Bidirectional data transfer
- Three-line handshake
- High data transfer rate of max. 1 MByte/s
- Up to 15 devices can be connected
- Maximum length of the connecting cables 15 m. The length of a single connecting cable should not exceed 2 m, if many devices are used, it should not exceed 1 m.
- Wired OR if several instruments are connected in parallel

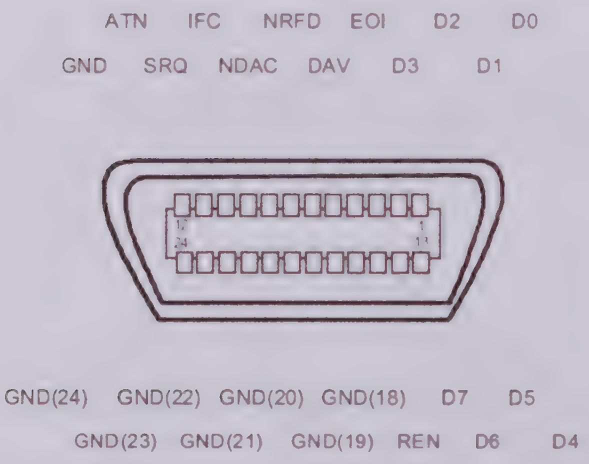


Fig. 8-1 Pin Assigment of the GPIB bus interface

Bus Lines

1. Data bus with 8 lines D0 to D7

The transmission is bit-parallel and byte-serial in the ASCII/ISO code. D0 is the least significant bit, D7 the most significant bit.

2. Control bus with 5 lines

IFC (Interface Clear),
active LOW resets the interfaces of the instruments connected to the default setting.

ATN (Attention),
active LOW signals the transmission of interface messages
inactive HIGH signals the transmission of device messages.

SRQ (Service Request),
active LOW enables the connected device to send a service request to the controller.

REN (Remote Enable),
active LOW permits switchover to remote control.

EOI (End or Identify),
has two functions in connection with ATN:

ATN=HIGH	active LOW marks the end of data transmission.
ATN=LOW	active LOW triggers a parallel poll.

3. Handshake bus with three lines

DAV (Data Valid),
active LOW signals a valid data byte on the data bus.

NRFD (Not Ready For Data),
active LOW signals that one of the connected devices is not ready for data transfer.

NDAC (Not Data Accepted),
active LOW signals that the instrument connected is accepting the data on the data bus.

Interface Messages

Interface messages are transmitted to the instrument on the data lines, with the attention line being active (LOW). They serve to communicate between controller and instrument.

Universal Commands

Universal commands are encoded in the range 10 through 1F hex. They are effective for all instruments connected to the bus without pervious addressing.

Table 8-1 Universal Commands

Command	QuickBASIC command	Effect on the instrument
DCL (Device Clear)	IBCMD (controller%, CHR$(20))	Aborts processing of the commands just received and sets the command processing software to a defined initial state. Does not change the instrument setting
IFC (Interface Clear)	IBSIC (controller%)	Resets the interfaces to the default setting
LLO (Local Lockout)	IBCMD (controller%, CHR$(17))	Locks switchover from remote control to *Local* (manual control) by means of the front panel keys

Addressed Commands

Addressed commands are encoded in the range 00 through 0F hex. They are only effective for instruments addressed as listeners.

Table 8-2 Addressed Commands

Command	QuickBASIC command	Effect on the instrument
GTL (Go to Local)	IBLOC (device%)	Transition to the *Local* state (manual control).

Note: *The CMU can not be configured as a high-speed HS488 listener; the commands CFE (Configure Enable) and CFGn (Configure) are not supported.*

Serial Interfaces (COM 1, COM 2)

The CMU is equipped with two serial RS-232-C interfaces. The two assigned 9-pin standard Sub-D male connectors are designated with COM 1 and COM 2 and located on the rear panel. A controller can be connected via this interface for remote control.

The two RS-232 interfaces provide two independent channels which can be active simultaneously. However, setting commands and queries act on the same device hardware. The interfaces are activated and configured in the *Setup - Remote* menu or via remote control using the commands `SYSTem:COMMunicate...`

Interface characteristics

- Serial data transmission in asynchronous mode,
- Bidirectional data transmission via two separate lines,
- Transmission rate selectable from 110 to 115200 baud,
- Logic 0 signal from +3 V to +15 V,
- Logic 1 signal from -15 V to -3 V,
- An external instrument (controller) can be connected,
- Hardware handshake RTS/CTS or software handshake XON/XOFF can be selected.

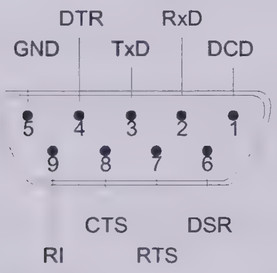


Fig. 8-2 Pin assignment of the RS-232-C interface

Designation	Abbreviation	Pin (9-pin male)	Pin (25-pin male)
Data Carrier Detect	DCD	1	8
Receive Data	RxD	2	3
Transmit Data	TxD	3	2
Data Terminal Ready	DTR	4	20
Signal Ground	GND	5	7
Data Set Ready	DSR	6	6
Request To Send	RTS	7	4
Clear To Send	CTS	8	5
Ring Indicator	RI	9	22

Signal lines

1. Data lines

RxD (Receive Data)
Input data.

Data transfer is bit-serial in the ASCII code, starting with the least significant bit (LSB).

TxD (Transmit Data)
Output data.

Data transfer is bit-serial in the ASCII code, starting with the least significant bit (LSB). The two data lines RxD and TxD are a minimum requirement for data transfer. The following control lines are necessary in addition if a hardware handshake is to be used.

2. Control and message lines

DCD (Data Carrier Detect)
active LOW.
Input; using this signal the data terminal recognizes that the modem of the remote station receives valid data with a sufficient signal level. DCD is used to disable the receiver in the data terminal and prevent reading of false data if the modem cannot interpret the signals of the remote station.

DTR (Data Terminal Ready)
active LOW,
Output; with DTR, the instrument indicates that it is ready to receive data.

DSR (Data Set Ready)
active LOW,
Input; DSR indicates to the instrument that the remote station is ready to receive data.

RTS (Request To Send)
active LOW.
Output; with RTS, the instrument indicates that it is ready to receive data. The RTS line controls whether the instrument is ready to receive data or not.

CTS (Clear To Send)
active LOW.
Input; CTS tells the instrument that the remote station is ready to receive data.

RI (Ring Indicator)
active LOW.
Input; RI is used by a modem to indicate that a remote station wants to set up a connection.

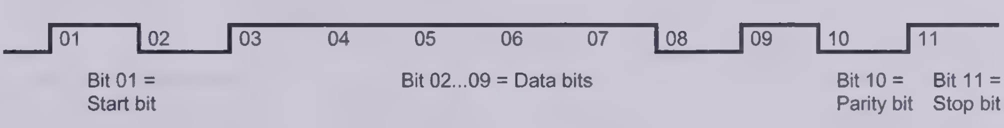
Transmission Parameters

In order to ensure error-free and correct data transmission, the parameters of the instrument and the controller must be set identically. The parameters of the RS-232 interface can be set via the *Setup - Remote* menu or the command group `SYSTem:COMMunicate...`

Table 8-3 Transmission parameters of the RS-232 interface

Parameter	Default	Description / Parameter Range
Baud rate	9600 baud[1]	The instrument allows baud rates between 110 and 115200 baud to be set, see chapter 4, *Setup - Remote* menu.
Data bits	8	Data transmission is in the 7- or 8-bit ASCII code, starting with the least significant bit (LSB).
Start bit	1	Each data byte begins with a start bit. The falling edge of the start bit indicates the beginning of the data byte.
Parity bit	None	A parity bit can be transmitted for error protection. The settings *No parity*, *even* or *odd* parity are allowed.
Stop bit	1	Transmission of a data byte is terminated by one or two stop bits. The sum of data bits and stop bits must be equal to 9.

Example: Transmission of character 'A' (41 Hex) in 8-bit ASCII code with even parity and one stop bit:



Interface functions

For interface control, some control characters from the ASCII code range of 0 to 20 hex are predefined and can be transmitted via the interface.

Table 8-4 Control strings or control characters of the RS-232-C interface

Control Character	Function
Break (at least 1 character only log 0)	Reset instrument
0Dhex, 0Ahex	Terminator <CR>, <LF> Switchover between local / remote

---

[1] The default baud rate is 19200 baud for COM ports that are used as GPIB connectors.

Handshake

Software handshake

In case of a software handshake data transfer is controlled using the two control characters XON / XOFF:

- The CMU uses the control character XON to indicate that it is ready to receive data.
- If the receive buffer is full it sends the XOFF character via the interface to the controller. The controller interrupts data output until it receives another XON from the CMU.
- In the same way the controller indicates to the CMU that it is ready to receive data.

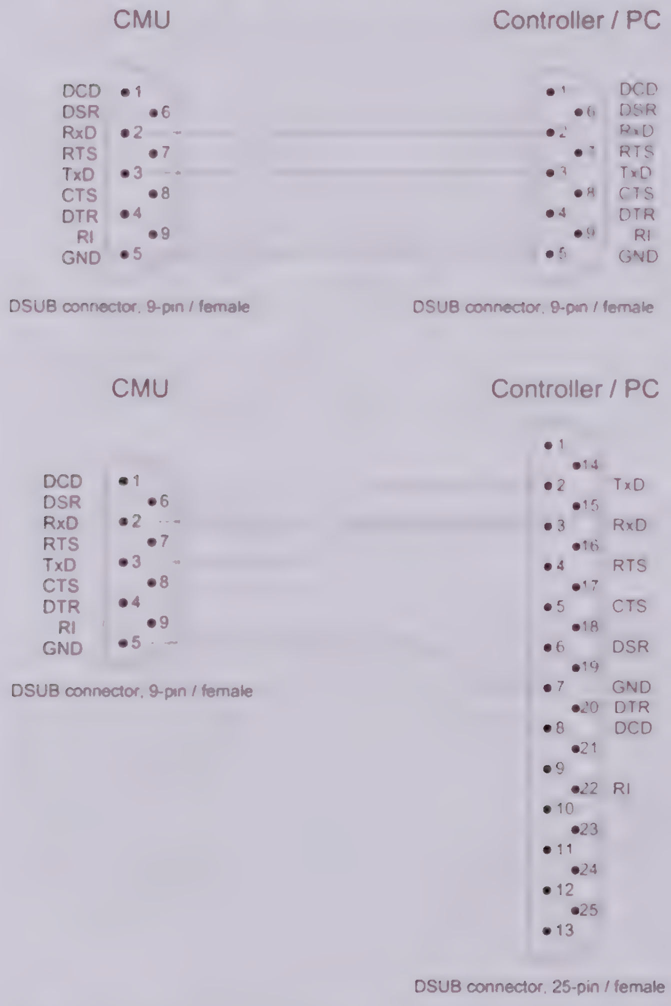

CMU
Controller / PC
DCD
DSR
RxD
RTS
TxD
CTS
DTR
RI
GND
1
6
2
7
3
8
4
9
5
DCD
DSR
RxD
RTS
TxD
CTS
DTR
RI
GND
DSUB connector, 9-pin / female
DSUB connector, 9-pin / female
CMU
Controller / PC
DCD
DSR
RxD
RTS
TxD
CTS
DTR
RI
GND
DSUB connector, 9-pin / female
1
14
2 TxD
15
3 RxD
16
4 RTS
17
5 CTS
18
6 DSR
19
7 GND
20 DTR
8 DCD
21
9
22 RI
10
23
11
24
12
25
13
DSUB connector, 25-pin / female

Fig. 8-3 Wiring of the data lines for software handshake

Connection between instrument and controller (Null-modem cable)

The connection of the instrument to a controller is made with a so-called null-modem cable. Here, the data, control and signalling lines must be crossed. The wiring diagram on the left applies to a controller with a 9-pin or 25-pin configuration.

Hardware handshake

In case of a hardware handshake, the instrument signals that it is ready for reception via line DTR and RTS. A logic '0' means "ready" and a '1' means "not ready". The RTS line is always active (logical '0'), provided that the serial interface is switched on. The DTR line controls whether the analyzer is ready for reception or not.

The CTS or DSR lines (see signal lines) tell the instrument whether the remote station is ready for reception or not. A logical '0' on both lines switches on data transmission, a logical '1' on both lines stops data transmission of the generator. The TxD line is used for data transfer.

Connection between instrument and controller (Null-modem cable)

The connection of the instrument to a controller is made with a so-called null-modem cable. Here, the data, control and signalling lines must be crossed. The wiring diagram on the left applies to a controller with a 9-pin or 25-pin configuration.

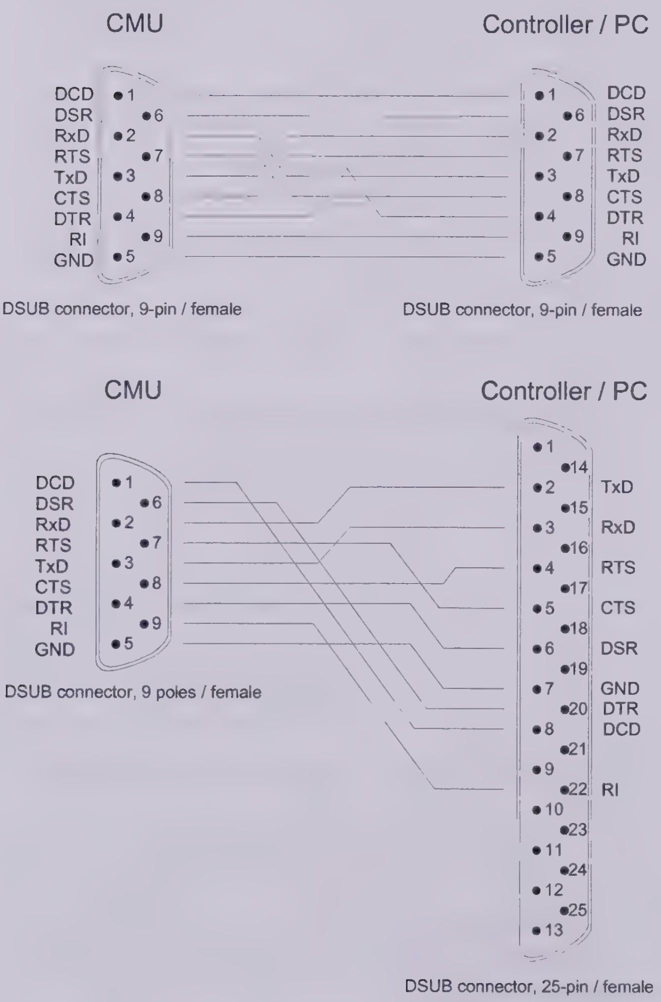

CMU
Controller / PC
DCD •1
DSR •6
RxD •2
RTS •7
TxD •3
CTS •8
DTR •4
RI •9
GND •5
•1 DCD
•6 DSR
•2 RxD
•7 RTS
•3 TxD
•8 CTS
•4 DTR
•9 RI
•5 GND
DSUB connector, 9-pin / female
DSUB connector, 9-pin / female
CMU
Controller / PC
DCD •1
DSR •6
RxD •2
RTS •7
TxD •3
CTS •8
DTR •4
RI •9
GND •5
DSUB connector, 9 poles / female
•1
•14
•2 TxD
•15
•3 RxD
•16
•4 RTS
•17
•5 CTS
•18
•6 DSR
•19
•7 GND
•20 DTR
•8 DCD
•21
•9
•22 RI
•10
•23
•11
•24
•12
•25
•13
DSUB connector, 25-pin / female

Fig. 8-4 Wiring of the data, control and message lines for hardware handshake

Connectors for Peripherals

Printer Connector (LPT)

The 25-pin standard Sub-D female connector LPT on the rear panel of the CMU is intended for connecting a printer. The interface is CENTRONICS compatible.

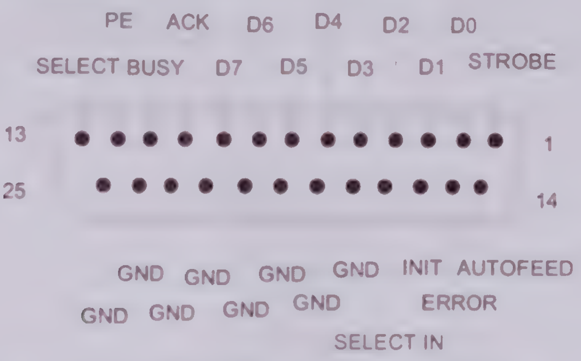
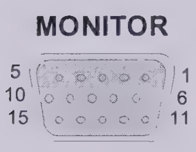


Fig. 8-5 Pin assignment of the LPT connector

Pin	Signal	Input (I) Output (O)	Description
1	STROBE	O	Impulse for transfer of a data byte, 1µs pulse width at minimum (active LOW)
2	D0	O	Data line 0
3	D1	O	Data line 1
4	D2	O	Data line 2
5	D3	O	Data line 3
6	D4	O	Data line 4
7	D5	O	Data line 5
8	D6	O	Data line 6
9	D7	O	Data line 7
10	ACK	I	Indicates that the printer is ready to receive the next byte (active LOW)
11	BUSY	I	Signal active if the printer is unable to receive data
12	PE	I	The signal is activated if no printer paper is available (active HIGH)
13	SELECT	I	The signal is activated when the printer is selected (active HIGH).
14	AUTOFEED	O	If the signal is active the printer inserts a line feed after each line (active LOW).
15	ERROR	I	The signal is activated if no printer paper is available or an error occurred (active LOW).
16	INIT	O	Initializing the printer (active LOW)
17	SELECT IN	O	If the signal is active the codes DC1/DC3 are ignored by the printer (active LOW).
18 - 25	GND		Connected to ground

Monitor Connector (MONITOR)

The 15-pin Sub-D female connector MONITOR at the rear panel of the CMU is intended for connecting an external VGA monitor.

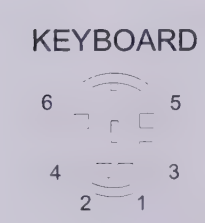


Pin No.	Signal
1	RED (output)
2	GREEN (output)
3	BLUE (output)
4	MID2 (NC)
5	NC
6	R-GND
7	G-GND
8	B-GND
9	NC
10	GND
11	MID0 (NC)
12	MID1 (NC)
13	HSYNC (output)
14	VSYNC (output)
15	NC

Fig. 8-6 Pin assignment of the MONITOR connector

Keyboard Connector (KEYBOARD)

The 6-pole Mini DIN female connector KEYBOARD at the rear of the instrument is intended for connecting an external keyboard. .



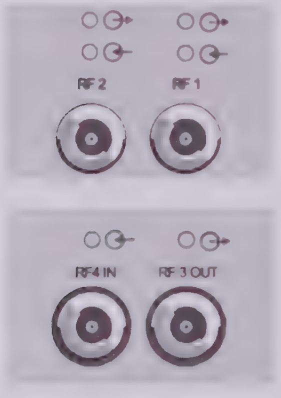
Pin No.	Signal
1	Keyboard data (input)
2	Msdata
3	GND
4	+5 V keyboard power supply (output, max. 0.1 A)
5	Keyboard clock (output)
6	Msclock
Shield	GND

Fig. 8-7 Pin assignment of the KEYBOARD socket

Signal Inputs and Outputs

RF Connectors

The N sockets on the front panel labeled RF1, RF 2, RF 3 OUT and RF4 IN are used as inputs and outputs for RF signals.



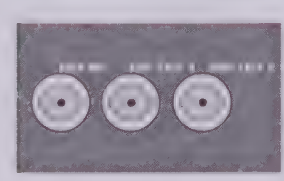
Bidirectional RF connectors

Unidirectional RF connectors

Fig. 8-8 RF connectors

Inputs and Outputs for the Reference Frequency (REF...)

The BNC sockets on the rear panel labeled REF IN, REF OUT 1 and REF OUT2 are used for synchronization of the CMU with external devices.

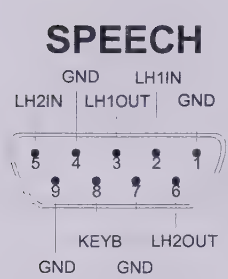


REF IN	This input is used to synchronize the CMU to other instruments. The frequency of the external reference signal fed in at REF IN must be set in the *Sync.* index card of the *Connection Control* menu or via the `CONFigure:SYNChronize:FREQuency:REFerence` command.
REF OUT 1	A signal for synchronization of other instruments is available at this output connector. This signal is either the reference frequency of the CMU or the signal applied to the input REF IN (see *Sync.* index card of the *Connection Control* menu).
REF OUT 2	A clock signal applied to this output and can be used for synchronizing external devices. The clock frequency can be selected from a list of network-specific frequencies in the *Sync.* index card of the *Connection Control* menu.

Fig. 8-9 Inputs and outputs for reference frequency

AF Connector SPEECH (Optional)

The 9-pin Sub-D female connector *SPEECH* on the front panel of the instrument can be used for connecting a handset to the signalling unit.

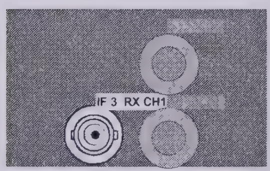

SPEECH
GND
LH1IN
LH2IN
LH1OUT
GND
5
4
3
2
1
9
8
7
6
KEYB
LH2OUT
GND
GND

Pin No.	Signal	Input (I) / Output (O) / Bidirectional (B)	Description
1	GND	B	
2	LH1HAND SETIN	I	AF signals to signalling unit 1
3	LH1HAND SETOUT	O	AF signals from signalling unit 1
4	GND	B	
5	LH2HAND SETIN	I	Signals to signalling unit 2
6	LH2HAND SETOUT	O	Signals from signalling unit 2
7	GND	B	
8	+5VKEYB	O	Power supply +5.2 V, max. 100 mA
9	GND	B	

Fig. 8-10 AF connector SPEECH

IF Signal

One BNC connector providing an IF signal is located on the rear panel of the CMU.



IF3 RX CH1 connector (BNC socket), provides an IF signal from the RXTX board 1 for monitoring purposes.

Fig. 8-11 IF signal output

Service and Auxiliary Connectors

A 9-pin Sub-D female connector *SERVICE* for the modules RXTX Boards is located on the rear panel. This connector is intended for internal tests only and must not be used as a signal input or output.

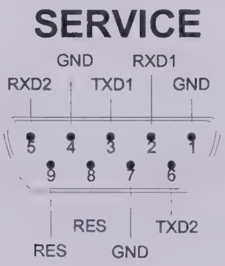
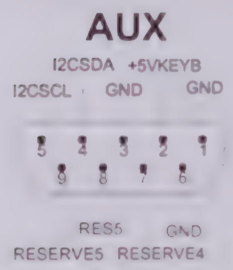

SERVICE
GND
RXD1
RXD2
TXD1
GND
5
4
3
2
1
9
8
7
6
RES
TXD2
RES
GND

Fig. 8-12 SERVICE connector

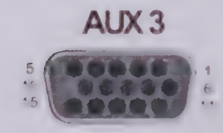
A 9-pin SUB-D female connector AUX on the rear panel provides a +5.2 V power supply. The pin assignment is as follows:



Pin	Signal	Input (I) / Output (O) / Bidirectional (B)	Description
1	GND	B	GND
2	+5VKEYB	O	Power supply +5 2 V max 100 mA
3	GND	B	GND
4	I2CSDA	B	For future extensions
5	I2CSCL	O	For future extensions
6	GND	B	GND
7	RESERVE4	B	
8	RESERVE5	B	
9	RESERVE6	B	

Fig. 8-13 AUX connector

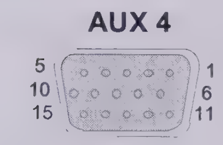
The 15-pin SUB-D female connector AUX 3 on the front panel is used as an input or output for status, control, and trigger signals. These signals are applied to particular (in some function groups: selectable) pins of the AUX 3 connector (refer to the corresponding menu).
The pin assignment of the AUX 3 connector is as follows:



Pin	Signal	Input (I) / Output (A) / Bidirectional (B)	Description
1	GND	B	
2	TBUS1	O	Timing output A Test signal CH1 GSMxxx-MS Signalling: Frame trigger (see GSMxxx-MS operating manual)
3	TBUS2	O	Timing output B
4	TBUS3	O	Timing output C
5	TBUS4	O	Timing output D
6	TBUS5	I	External trigger input CMU300: External trigger signal for wired synchronization
7	TBUS6	I	External trigger B
8	TBUS7	I	External trigger A External trigger signal CH1 input for *Spectrum* and *Power* measurements
9	GND	B	GND
10	GND	B	GND
11	GND	B	GND
12	GND	B	GND
13	GND	B	GND
14	GND	B	GND
15	GND	B	GND

Fig. 8-14 AUX 3 connector

The 15-pin SUB-D female connector AUX 4 on the rear panel is used as an input or output for status, control, and trigger signals. These signals are applied to definite pins of the AUX 4 connector (refer to the corresponding menu).
The pin assignment of the AUX 4 connector is as follows:

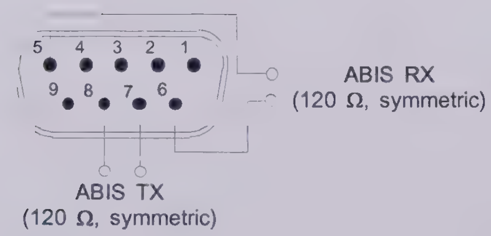


Pin	Signal	Input (I) / Output / Bidirectional (B)	Description
1	GND	B	GND
2	GND	B	GND
3	GND	B	GND
4	GND	B	GND
5	GND	B	GND
6	GND	B	GND
7	GND	B	GND
8	GND	B	GND
9	TBUS8	B	Status/control/trigger signal
10	TBUS9	B	Status/control/trigger signal
11	TBUS10	B	Status/control/trigger signal
12	TBUS11	B	Status/control/trigger signal
13	TBUS12	B	Status/control/trigger signal
14	TBUS13	B	Status/control/trigger signal
15	TBUS14	B	Status/control/trigger signal

Fig. 8-15 AUX 4 connector

Abis Connector (CMU300 with Option CMU-B71 only)

A 9-pin SUB-D female connector ABIS on the rear panel provides a symmetric (balanced) input of the *Abis Interface Unit for CMU* (option CMU.B71; for CMU300 only). The pin assignment is as follows:

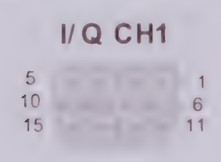


Pin	Signal	Input (I) / Output (O) / Bidirectional (B)	Description
1	–	–	Not connected
2	–	–	Not connected
3	–	–	Not connected
4	–	–	Not connected
5	ABIS RX	I	Symmetric Abis input
6	ABIS RX	I	Symmetric Abis input
7	ABIS TX	O	For future extensions
8	ABIS TX	O	For future extensions
9	GND	B	GND

Fig. 8-16 ABIS connector

I/Q CH1 Connector (CMU200 with Option CMU-B17 only)

A 15-pin SUB-D female connector I/Q CH1 provides the inputs and outputs for I/Q signals (option CMU-B17). The pin assignment is as follows:



Pin	Signal	Input (I) / Output (O) / Bidirectional (B)	Description
1	GND	–	–
2	MOD_I_IN	I	I input, TX path max ±0.5 V, impedance 50 Ohm
3	MOD_Q_IN	I	Q input, TX path, max ±0.5 V, impedance 50 Ohm
4	GND	–	–
5	MOD_I_OUT	O	I output, TX path max ±0.5 V, impedance 50 Ohm
6	MOD_Q_OUT	O	Q output, TX path, max ±0.5 V, impedance 50 Ohm
7	GND	–	–
8	DEMOD_I_IN	I	I input, RX path, max ±0.5 V, impedance 50 Ohm
9	DEMOD_Q_IN	I	Q input, RX path max ±0.5 V, impedance 50 Ohm
10	GND	–	–
11	DEMOD_I_OUT	O	I output, RX path max ±0.5 V, impedance 50 Ohm
12	DEMOD_Q_OUT	O	Q output, RX path, max ±0.5 V, impedance 50 Ohm
13	GND	–	–
14	–	–	–
15	–	–	–

Fig. 8-17 I/Q CH1 connector

IF3 Connectors (CMU200 with Option CMU-B17 only)

Four BNC connectors provide the inputs and outputs for IF signals (option CMU-B17). The BNC shield of all these connectors is connected to GND. The remaining specifications are as follows:

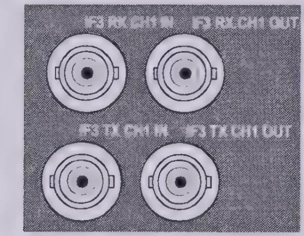


Fig. 8-18 IF3 connectors

Connector	**Function**
IF3 RX CH1 IN	IF input, RX path, f= 7,68 MHz or 10,7 MHz; max level +2 dBm PEP; impedance 50 Ohm
IF3 RX CH1 OUT	IF output, RX path, f= 7,68 MHz or 10,7 MHz; max level +4 dBm PEP; impedance 50 Ohm
IF3 TX CH1 IN	IF input, TX path, f= 15,36 MHz or 13,85 MHz; max level +3 dBm PEP for WCDMA, max level –5 dBm for GSM; impedance 50 Ohm
IF3 TX CH1 OUT	IF output, TX path, f= 15,36 MHz or 13,85 MHz; max level +3 dBm PEP for WCDMA, max level –5 dBm for GSM; impedance 50 Ohm

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9 Error Messages

SCPI Error Messages

SCPI error messages are the same in all SCPI instruments. The errors are assigned negative numbers. The standard text of the error message is often supplemented by a comment from the CMU which provides more detailed information (device-dependent information). Since this part depends on the individual situation, it often contains more relevant information than the standard text.

No error

Error code	Explanation
0	**No error** This message is output when there are no entries in the error queue.

Command error

The following errors cause bit 5 in the ESR register to be set.

Error code	Explanation
-100	**Command error** Generic error message that cannot detect a more specific error.
-101	**Invalid character** The command contains a character which is invalid for that type.
-102	**Syntax error** The data type received is not accepted at this position.
-103	**Invalid separator** The semicolon was omitted after a program message unit.
-104	**Data type error** The recognized data element is of the wrong type (e.g. character data instead of numeric data)
-105	**GET not allowed** A GET was received within a program message.
-108	**Parameter not allowed** The command contains parameters at a position where they are not accepted.
-109	**Missing parameter** The command does not contain the required parameters.

Error code	Explanation
-111	**Header separator error** A character which is not a legal header separator was encountered while parsing the header; for example, no white space followed the header.
-112	**Program mnemonic too long** The header contains more than 12 characters.
-113	**Undefined header** The sent command header has not been defined
-114	**Header suffix out of range** The command contains an illegal numeric suffix
-120	**Numeric data error** An invalid character for the data type being parsed was encountered.
-121	**Invalid character in number** The command contains an illegal numeric suffix.
-123	**Exponent too large** The magnitude of the exponent is too large
-124	**Too many digits** The decimal numeric data element contains too many digits
-128	**Numeric data not allowed** The command contains a numeric data element the device does not accept in this position.
-131	**Invalid suffix** The suffix is not appropriate for this command.
-134	**Suffix too long** The suffix contains more than 12 characters
-138	**Suffix not allowed** A suffix is not allowed for this command or at this point of the command.
-141	**Invalid character data** The character data element contains an invalid character or the element is not valid for this command.
-144	**Character data too long** The character data element contains more than 12 characters.
-148	**Character data not allowed** The character data is prohibited for this command or at this point of the command.
-151	**Invalid string data** A string data element was expected, but was invalid for some reason.

Error code	Explanation
-158	**String data not allowed** The command contains a legal string data element which is not allowed at this point.
-161	**Invalid block data** The command contains illegal block data, e.g. no numeric data element is sent after the introductory #.
-168	**Block data not allowed** The command contains legal block data which are not allowed at this point.
-171	**Invalid expression** The expression data element was invalid; for example, unmatched parentheses or an illegal character.
-178	**Expression data not allowed** A legal expression data was encountered but was not allowed by the device at this point in parsing.
-180	**Macro error** An error occurred when defining a macro or executing a macro.

Execution error

The following errors cause bit 4 in the ESR register to be set.

Error code	Explanation
-200	**Execution error** An execution error as defined in IEEE 488.2, has occurred.
-203	**Command protected**
-211	**Trigger ignored** A triggering signal was received and recognized by the device but was ignored because of timing considerations.
-212	**Arm ignored** An arming signal was received and recognized by the device but was ignored.
-213	**Init ignored** A request for a measurement initiation was ignored as another measurement was already in progress.
-221	**Settings conflict** A setting contradicts another setting. The last attempted setting was not executed.
-222	**Data out of range** A value of the transmitted command was outside the legal range.
-223	**Too much data** More data were sent by the host than the CMU can handle.

Error code	Explanation
-224	**Illegal parameter value** An exact value, from a list of possible values, was expected but not received.
-225	**Out of memory** The CMU software has insufficient memory to perform the requested operation.
-230	**Data corrupt or stale** Possibly invalid data; new reading started but not completed since last access.
-240	**Hardware error** A legal program command or a query could not be executed because of a hardware problem in the device.
-241	**Hardware missing** A legal program command or a query could not be executed because of a missing device hardware.
-250	**Mass storage error** A mass storage error occurred
-251	**Missing mass storage** A legal program command or a query could not be executed because of missing mass storage.
-252	**Missing media** A legal program command or a query could not be executed because of missing media; for example, no floppy disk.
-253	**Corrupt media** A legal program command or a query could not be executed because of corrupt media; for example, bad floppy disk or wrong format
-254	**Media full** A legal program command or a query could not be executed because of the media was full; for example, no room on the floppy disk.
-255	**Directory full** The specified directory is full – no more files can be written.
-256	**File name not found** A file with the specified name does not exist.
-257	**File name error** The specified file name cannot be used, e.g. because the file does not exist (reading, clearing) or already exists (writing, generation).
-258	**Media protected** A legal program command or a query could not be executed because the media was protected.

Device-specific error

The following errors cause bit 3 in the ESR register to be set.

Error code	Explanation
-300	**Device-specific error**
-310	**System error** An unspecified system error has occurred.
-311	**Memory error** An error was detected in the device's memory.
-313	**Calibration memory lost** Nonvolatile calibration data have been lost.
-314	**Save/recall memory lost** Nonvolatile saved data have been lost.
-315	**Configuration memory lost** Nonvolatile configuration data saved by the device have been lost.
-330	**Self-test failed** An error occurred during the internal self test.
-350	**Queue overflow** Error code entered in the queue in lieu of the code when the queue is full. It indicates that an error occurred but was not recorded in the queue. The original error message is lost.
-360	**Communication error** An unspecified communication error was detected.
-361	**Parity error in program message** Parity bit was not correct when data were received on a serial port.
-362	**Framing error in program message** No stop bit was detected when data were received on a serial port.
-363	**Input buffer overrun** Software or hardware input buffer on serial port overflows with data caused by improper or nonexistent pacing.

Query error - error upon data request

When the following error codes are output, bit 2 is set in the ESR register.

Error code	Explanation
-400	**Query error**
-410	**Query INTERRUPTED** The query was interrupted. Example: a query is followed by new data before a response was completely sent.
-420	**Query UNTERMINATED** An incomplete query was received Example: the device is addressed to talk although the received query was incomplete.
-430	**Query DEADLOCKED** A condition causing a DEADLOCKED query error occurred. Example: both input and output buffer are full and the device can not continue.
-440	**Query UNTERMINATED after indefinite response** A query was received in the same program message after a query requesting an indefinite response was execute

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